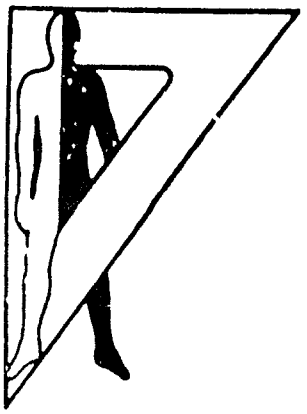

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Technical Note 3-83

"M" RANGE POP-UP TARGET TEST FACILITY

Bruce E. Amrein

February 1983
AMCMS Code 612716.H700011

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

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Data Acquisition
Shot Detector
Hit Detector

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The US Army Human Engineering Laboratory has developed a fully bermed, 35 position small arms pop-up target range which is fully instrumented to provide computer controlled scenario generation and the automatic collection of the following event data: time of shot, time of hit, time target appeared, time target disappeared, etc. This data can be processed by the Hewlett-Packard Model 9830 Calculator that drives the range to provide almost real-time data reduction.

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"M" RANGE POP-UP TARGET TEST FACILITY

Bruce E. Amrein

February 1983

APPROVED: John D. Weisz
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PREFACE

The author would like to acknowledge the technical assistance of the following personnel, without whose support this project would not have been possible:

Mr. John H. Rollins, Jr. constructed all of the circuit cards and cabling used in the automated pop-up target controller.

Mr. Thomas R. Slowik served as project engineer on all outside construction, including construction of the berms and installation of all electrical power and instrumentation cabling.

The personnel of the Human Engineering Laboratory Test Support Division constructed the berms, firing point, and provided the general support necessary to up-grade the physical appearance of the range.

CONTENTS

"M" RANGE POP-UP TARGET TEST FACILITY

INTRODUCTION

The U. S. Army Human Engineering Laboratory (USAHEL) has, for many years, utilized a temporary pop-up target facility located at "M" Range in the Aberdeen Area of Aberdeen Proving Ground. This facility has provided data which has been used to evaluate small arms weapons and the effects of gas masks, clothing, weapons configurations, etc. on the soldier's performance.

Over the past 2 years, extensive improvements to both the physical characteristics and the electronic instrumentation of the range have been made.

A fully bermed, 35 position pop-up target range has been installed with all control, data, and power wiring buried 36 inches underground or located behind protective berms.

Concurrently, a fully automated computer controlled pop-up target data acquisition system has been installed and interfaced to a Hewlett-Packard Model 9830 desk-top computer.

Figure 1 schematically shows both the inside and outside wiring of the range instrumentation and also shows related ancillary equipment which will be discussed in later sections.

DISCUSSION

Target Mechanism

The entire range is designed (both mechanically and electrically) around the standard military Target Holding Mechanism, Trainfire (M31A1)[1]. This mechanism is a motor-driven device designed for use in training for automatic or semiautomatic rifle fire and will accomodate target silhouettes up to 48 inches in height.

This mechanism operates from 115 VAC, 60 Hertz power. Control lines are provided to permit the mechanism to be commanded UP or DOWN. A switch or relay closure on the appropriate control line causes the bi-directional universal motor to raise or lower the target silhouette. Average time to traverse the 90° angle from horizontal to vertical (or vice versa) is approximately 1 second. This mechanism is ideally suited for this application since the motor is reversible at any point in its travel. Thus, a target may be commanded down without ever

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[1]Department of the Army. Operator organizational, direct support and general support maintenance manual including repair parts and special tools list for target holding mechanism, Trainfire: M31A1 (TM9-6920-203-14). Washington, DC:Author.

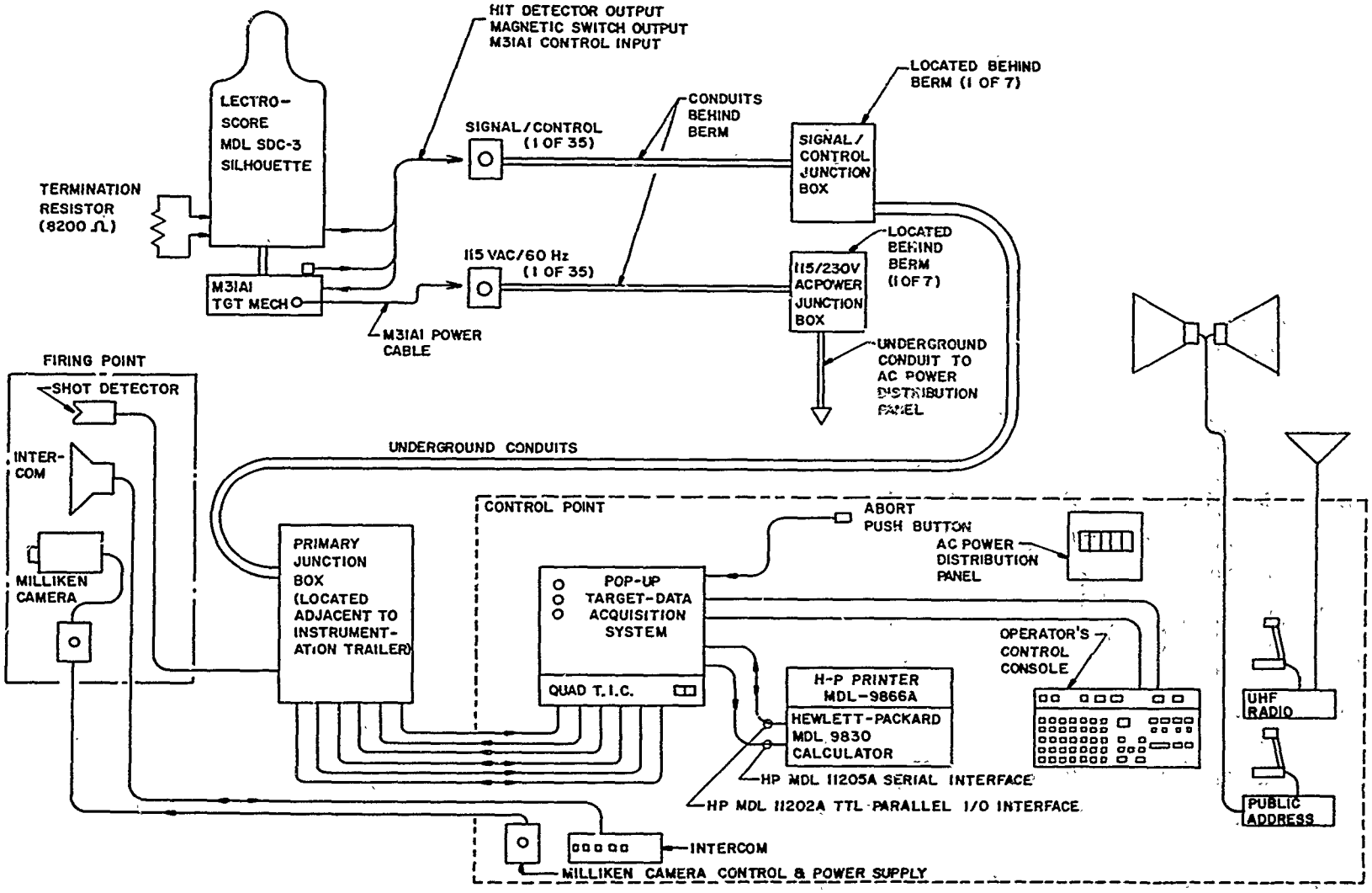

Figure 1. Schematic diagram of "M" Range instrumentation.

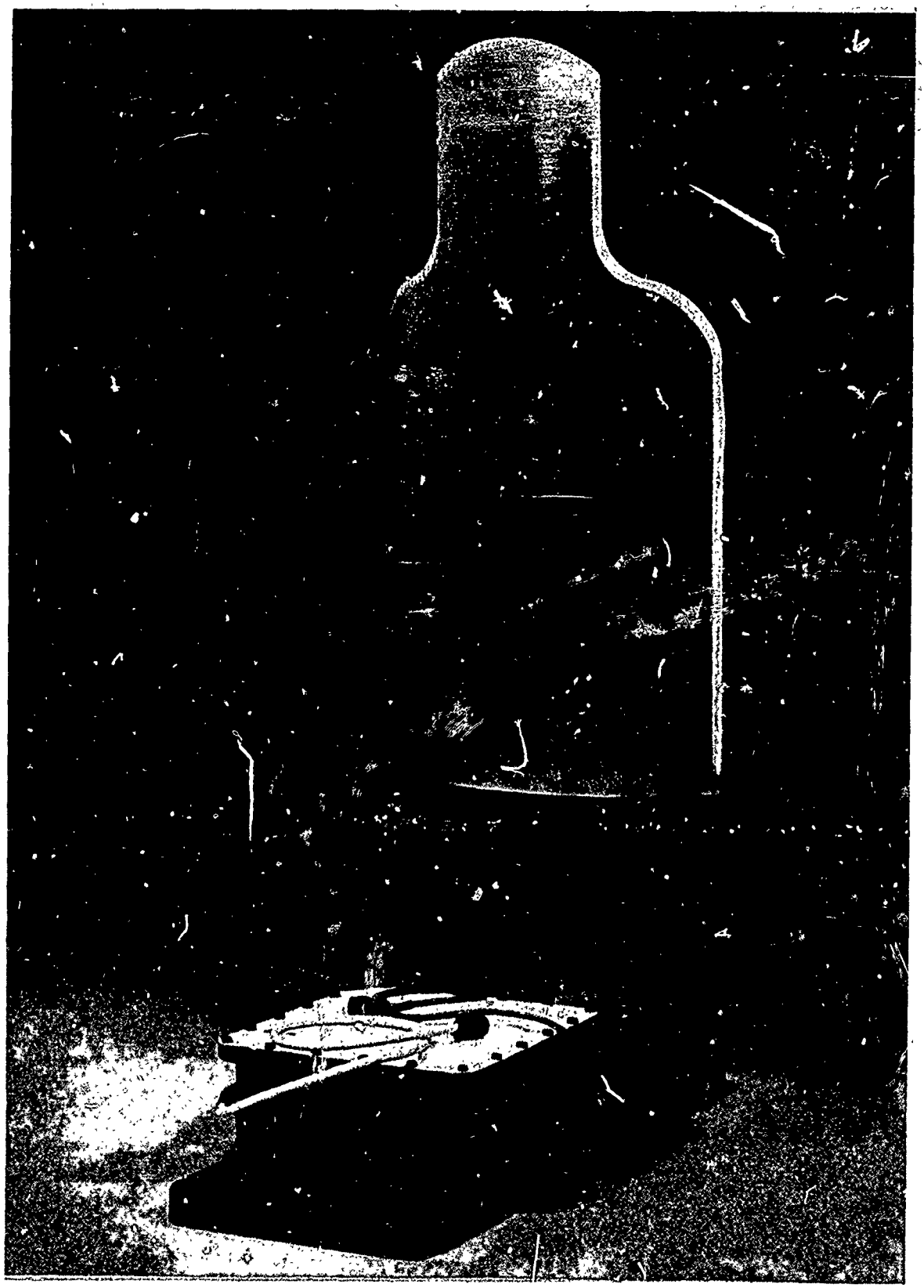

Figure 2. M31A1 target holding mechanism with target holder and silhouette.

reaching the fully up position. This provides instant feed-back to the shooter when a hit is scored while the silhouette is still traveling to its fully up position. Most other pop-up target mechanisms use a single direction motor and an eccentric cam which requires a silhouette to come fully up before it can begin its return trip to the horizontal position.

The M31A1 mechanism has been modified slightly to accommodate the metallic/foam silhouette which is used at this facility. The standard silhouette mount assembly, target holder, and target clamp bolt were discarded. In its place is mounted an HEL designed aluminium target holder which uses a standard commercial toggle clamp (De-Sta-Co Model Number 215-USS). Figure 2 shows the M31A1 mechanism with the HEL designed target holder in place; mounted in the holder is the electrical silhouette which will be discussed in the next section.

Also, each mechanism has been equipped with a magnetically actuated hermetically sealed switch which is located in close proximity to the target holding arm. A magnet has been mounted on the movable arm which keeps the normally open switch contacts closed when the arm is in the down position. At approximately 30° from horizontal, the switch changes state which indicates that the target holding arm is in motion.

Silhouette

The Pop-Up Target Test Facility utilizes a unique silhouette/hit detecting system. This system consists of an electrically sensitive silhouette which contains front and rear aluminium sheets separated by .375 inches of foam. These sheets or plates are insulated from ground and from each other. Figure 3 shows the details of the construction of a typical silhouette. This facility uses silhouettes of three different heights: 24, 36, and 48 inches. Speciality Die and Container Corporation has supplied these silhouettes as Lectro-Score Model SDC-3[2].

The silhouettes, which are connected via twisted-pair wires to the target controller (which will be discussed later), cause an electrical impulse of approximately 20 microseconds duration to be generated when a metallic projectile passes through the silhouette, compressing the foam material as the projectile bursts the front aluminium plate. As the projectile exits the silhouette the momentary short-circuit is broken. Up to 300 rounds (up to .45 caliber) have scored hits on a single silhouette without a sustained short-circuit within the silhouette (a metallic bridge from the front to rear plates) and without failing to detect a single hit. Silhouettes must be replaced when a high concentration of hits in a small physical area increases the likelihood of a projectile passing through an existing hole in the silhouette.

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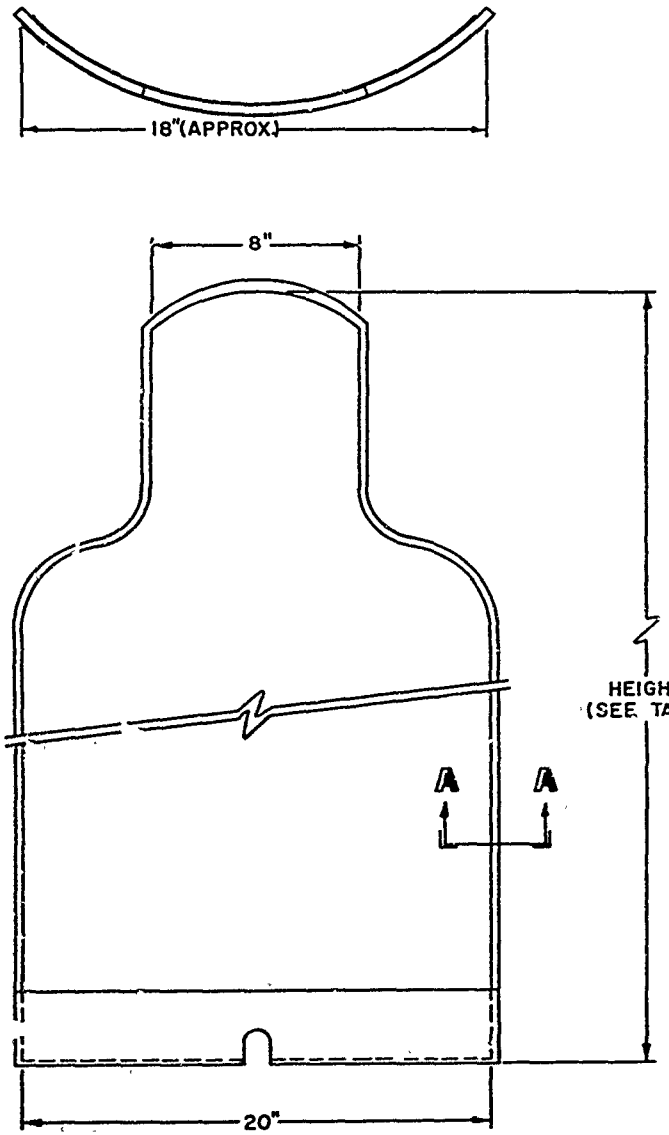
[2]Speciality Die & Container Corporation, 3725 East Baltimore Street, Baltimore, Maryland 21213.



TYPE	HEIGHT
A	48"
B	36"
C	24"

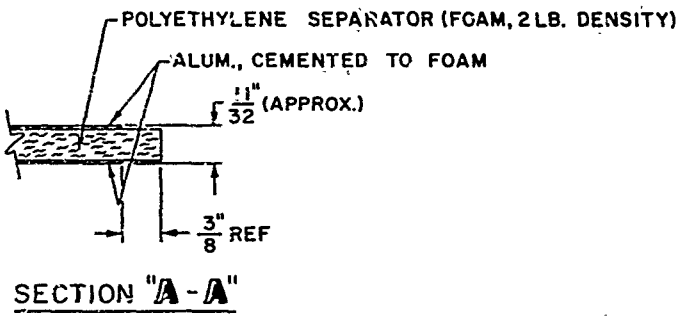


Figure 3. Electrically sensitive silhouette (construction details).

Obviously, this hit detection device is limited to the use of metallic projectiles. Plastic projectiles, unless coated with a conductive film, would fail to score hits. This technique is vastly more reliable than the impact switch detector which is standard on the M31A1 mechanism. With the impact switch hit detector, it is possible to shoot "into-the-dirt" in front of the silhouette, causing stones and gravel to impact on the silhouette and a hit to be scored. Non-metallic stones and gravel have absolutely no effect on the electrically sensitive hit detector in use at "M" Range.

Outside Construction

Outside construction at the "M" Range Pop-Up Target Test Facility has included the construction of earthen berms, underground and above ground wiring (signal and power), construction of the firing point, and installation of remote camera controls. These areas will be discussed later in this section.

Overview

The "M" Range Pop-Up Target Test Facility is located in the Michaelsville Test Area of Aberdeen Proving Ground. The center line of the range is located at 300° from 0°S with a permissible fan of fire of 30° to either side of the center of the range.

Pop-up targets are located at the 10-, 20-, 30-, 50-, 75-, 100- and 150-meter ranges. There are 5 targets located at each range for a total of 35 fixed location targets. The range is symmetrical about the center line. Figure 4 shows the location of each of the targets on the range and the limits of the firing fan.

Berms

Timber and earthen berms have been constructed the full length of each of the seven firing fans. Each berm is constructed of creosoted timbers (3" thick x 12" wide x 10' long) stacked two levels high (overall height is 24") and supported every 10 feet by 4" thick x 10" wide x 5 feet long creosoted timbers, which have been set 3 feet into the ground. The entire structure was assembled using 60 penny, hot-dipped, galvanized common nails. After construction of the timber retaining wall, earthen back-fill was placed against the front surface of the wall, sloping outward to a point approximately 3 feet in front of the timbers. This bulwark was seeded after tamping and leveling operations were completed. An area approximately 6-feet wide adjacent to the rear of the berm was filled with crusher run stone to provide a stable surface upon which to place the target mechanisms. Figure 5 shows a cross-section of the typical berm construction technique used on the range.

Under/Above Ground Wiring

All electrical wiring, both power and control and signal, is located in protected areas where the potential for damage by a projectile has been minimized.

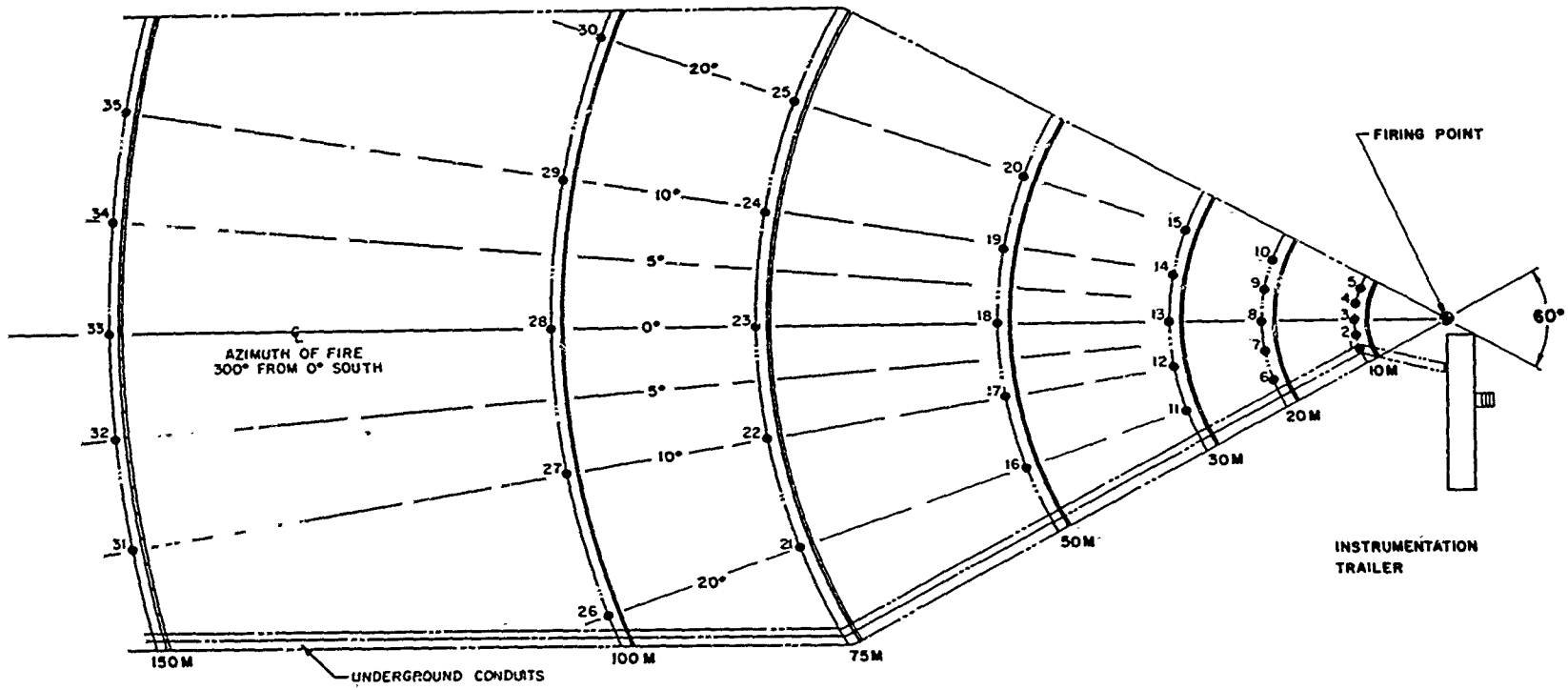


Figure 4. "M" Range pop-up target test facility: firing fan and target locations.

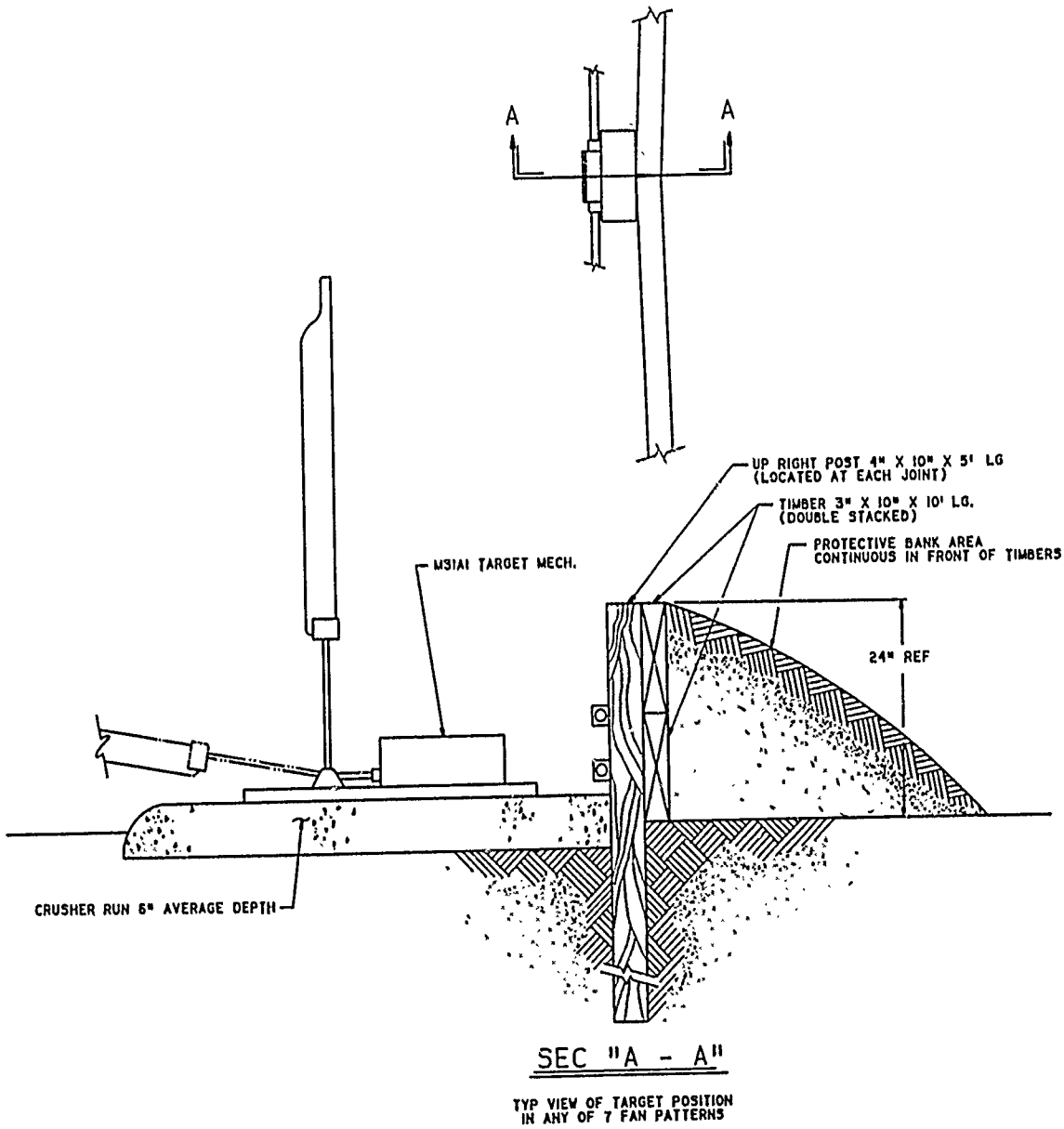


Figure 5. "M" Range: typical berm construction.

Undergrcund ducts are used from the primary junction boxes, which are located adjacent to the instrumentation trailer, to the secondary junction boxes which are located at each of the seven berms. Waterproof PVC conduit has been used for all underground duct runs and are buried 36 inches deep near the left limit of permissible fire. Each underground duct terminates behind the berm with a PVC junction box which is fastened to the timber berm in a protected area. Two junction boxes are provided at each berm. A 12-inch square waterproof junction box provides terminal space for the control and signal lines that are required for the five targets located at a given berm. An 8-inch square waterproof junction box provides terminals for the 115/230V AC power distribution system.

All power and signal and control lines are run exposed behind the timber berms in electrical metallic tubing (EMT). At each target mechanism location, there are two waterproof electrical boxes. Each box terminates with a waterproof connector that interfaces to the cables which are attached to the target mechanisms. One 3-pin connector provides the 115V AC power which is necessary to raise and lower the M31A1 Target-Holding Mechanism, while a 10-pin waterproof connector provides all control and signal lines to the target position. The function of these wires will be discussed in a later section.

Power Wiring

Each individual berm is provided with a 20 ampere, 115 volt AC, 60 Hertz circuit which provides power to the five M31A1 Target-Holding Mechanisms at a particular range. Each circuit is protected by a circuit breaker located in a wall mounted panel adjacent to the control point in the instrumentation trailer.

All power wiring to the target-holding mechanisms is completely waterproof and permit reliable operation under all weather conditions. The primary power distribution panel is protected by surge protectors and a driven ground-rod. Additionally, each secondary distribution box (at each of the seven berms) is protected by a driven ground-rod and surge protectors (NSN 5920-00-786-8448).

Signal/Control Wiring

Signal and control wires are provided to each of the 35 target mechanisms through a network of conduits from the primary junction box located adjacent to the instrumentation trailer. Each target mechanism is served by four twisted pairs of #22 AWG wire. The wires run underground from the primary junction box to the secondary junction boxes located at each berm. At each berm 20 wire pairs (plus spares) are routed to the 5 targets located at that berm (4 pairs/target).

The four pairs of wire are connected to the target mechanism through a 10-pin waterproof circular connector and cable and perform the following functions:

Pair 1	Connects electrically actuated silhouette to target controller.

Pair 2	Connects magnetic switch (which indicates target motion) to target controller.
Pair 3 & 4	Provide up/down control for M31A1 Target Holding Mechanism.

The functions of these pairs of wires will be discussed in more detail in the section which describes the target controller.

Firing Point

The firing point is a raised, covered earthen platform located at the apex of the firing fan. This platform is elevated approximately 24 inches above ground so as to give the firing subject an unobstructed view of the range in any position (prone, sitting, or standing).

The firing point is wired to accommodate the shot detector (which will be discussed later) that senses the muzzle blast of the weapon as the projectile exits the muzzle.

An intercommunications system has been installed to permit hands-off communications to the range controller from the firing point.

Additionally, the firing point has been wired to permit either local or remote control of a Milliken camera that is used to record the motions of the subject under study.

The Milliken cameras (Models DBM-4 and DBM-5) are high speed 16mm precision motion picture cameras designed to provide motion pictures of exceptional clarity and detail at frame rates as high as 500 frames per second under severe environmental conditions[3].

Inside Instrumentation

The control point for the "M" Range Pop-Up Target Test Facility is located in an elevated mobile home which has been modified to permit an unobstructed view of the firing point and the entire down-range target array.

The next several sections describe the automated, computer controlled Pop-Up Target Data Acquisition System which drives the entire range.

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[3]D. B. Milliken Company, 131 North Fifth Avenue, Arcadia, California.

Hardware

The Pop-Up Target Data Acquisition System physically consists of four major components which are interconnected with various cables and connectors and collects timing data on the following events: shots, hits, target silhouette appearance, and target silhouette disappearance. This data is transferred to the Hewlett-Packard Model 9830 Calculator for processing. Additionally, the operator's control console controls and monitors selection of targets to be presented, presentation times, delay times, target cart motion, open and short circuits, hits, shots, and also subject identification. Additionally, all of the above mentioned items can be selected and controlled by the Hewlett-Packard Calculator. The heart of the system is a 19" wide electronic cabinet which contains DC power supplies necessary to supply power to the system, the card cage which houses the wire-wrapped circuit cards which control the system, and the time interval counter subsystem (manufactured by Quad Systems, Inc).[4] Figure 6 shows a front view of this cabinet. The cabinet is interconnected to the remaining three major components which comprise the system.

All data and control lines are routed to the main electronic cabinet via a water-tight junction box which is located outside, adjacent to the control point. This junction box provides the interface between the target controller and the signal and control wires which were described earlier. Figure 7 shows the interior of the junction box as it appeared prior to connecting the down-range wiring.

Operator's Control Console

The operator's control console, shown in Figure 8, houses all controls, displays, and indicators necessary to operate the range. This console is connected to the main electronic cabinet via two cables which provide DC power and the 150 control lines necessary to operate the system. Figure 9 details the front panel of the operator's control console. The following functional descriptions are keyed to the indicators, displays, and controls referenced in Figure 9:

1 Silhouette Open Circuit Indicator

Provides a reference 1 Hertz flashing lamp which enables the operator to differentiate between open/short signals generated by Item 17.

2 Silhouette Short Circuit Indicator

Provides a reference 5 Hertz flashing lamp which enables the operator to differentiate between open/short signals generated by Item 17.

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[4]Quad Systems, Inc., 11900 Parklawn Drive, Rockville, Maryland 20852.

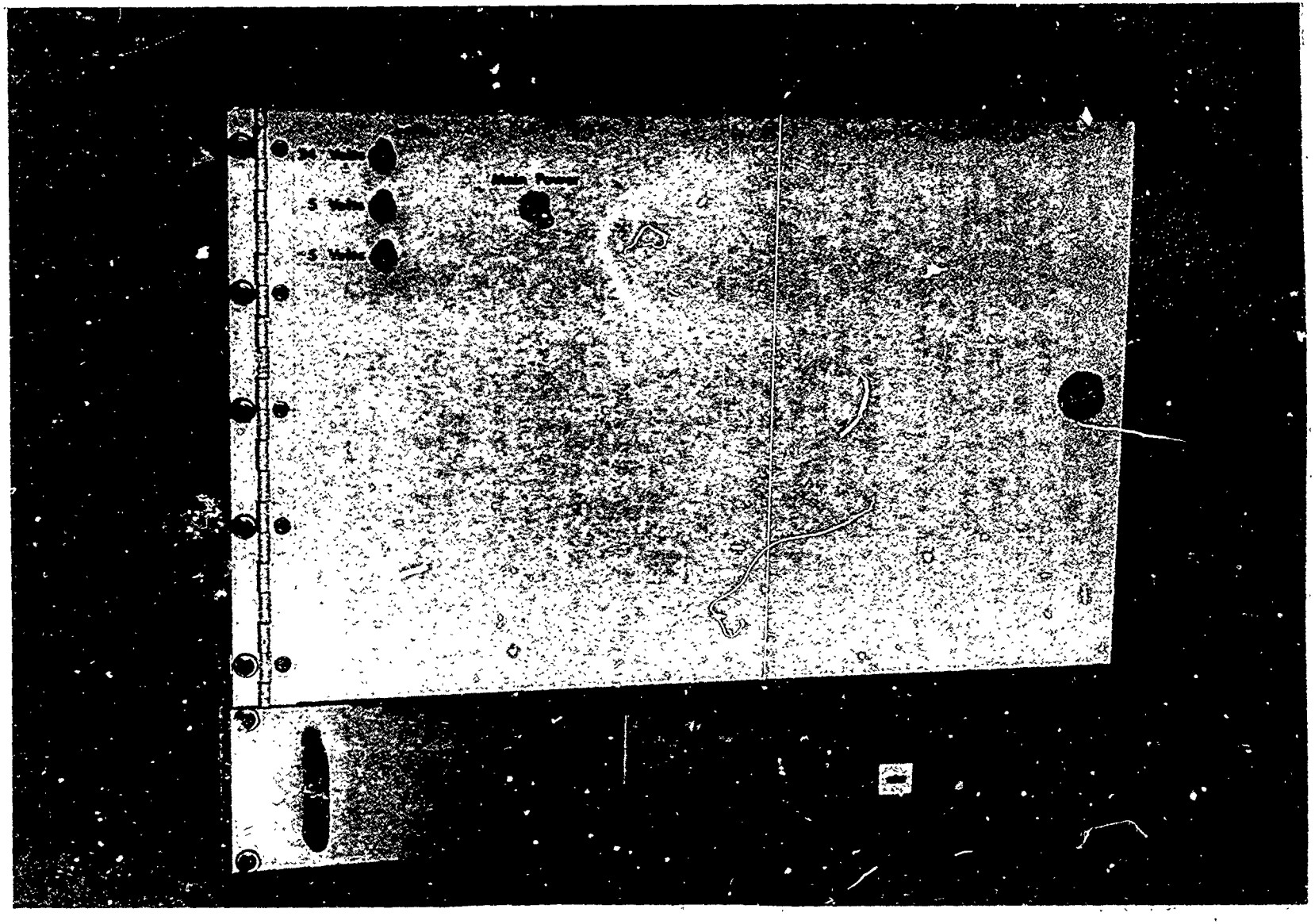

Figure 6. Pop-Up Target Data Acquisition System--electronics cabinet (front view).

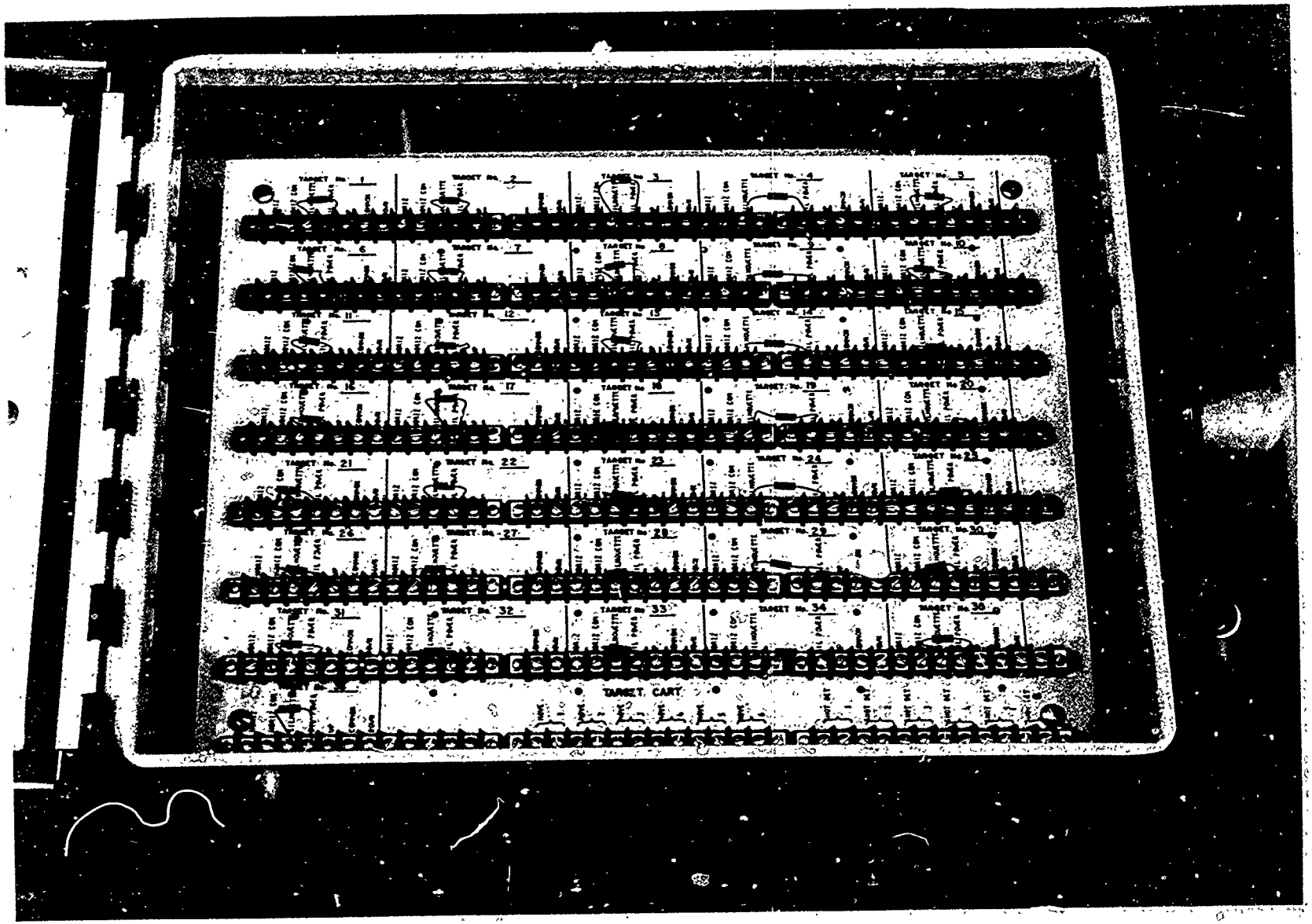

Figure 7. Pop-Up Target Data Acquisition System--junction box (interior).

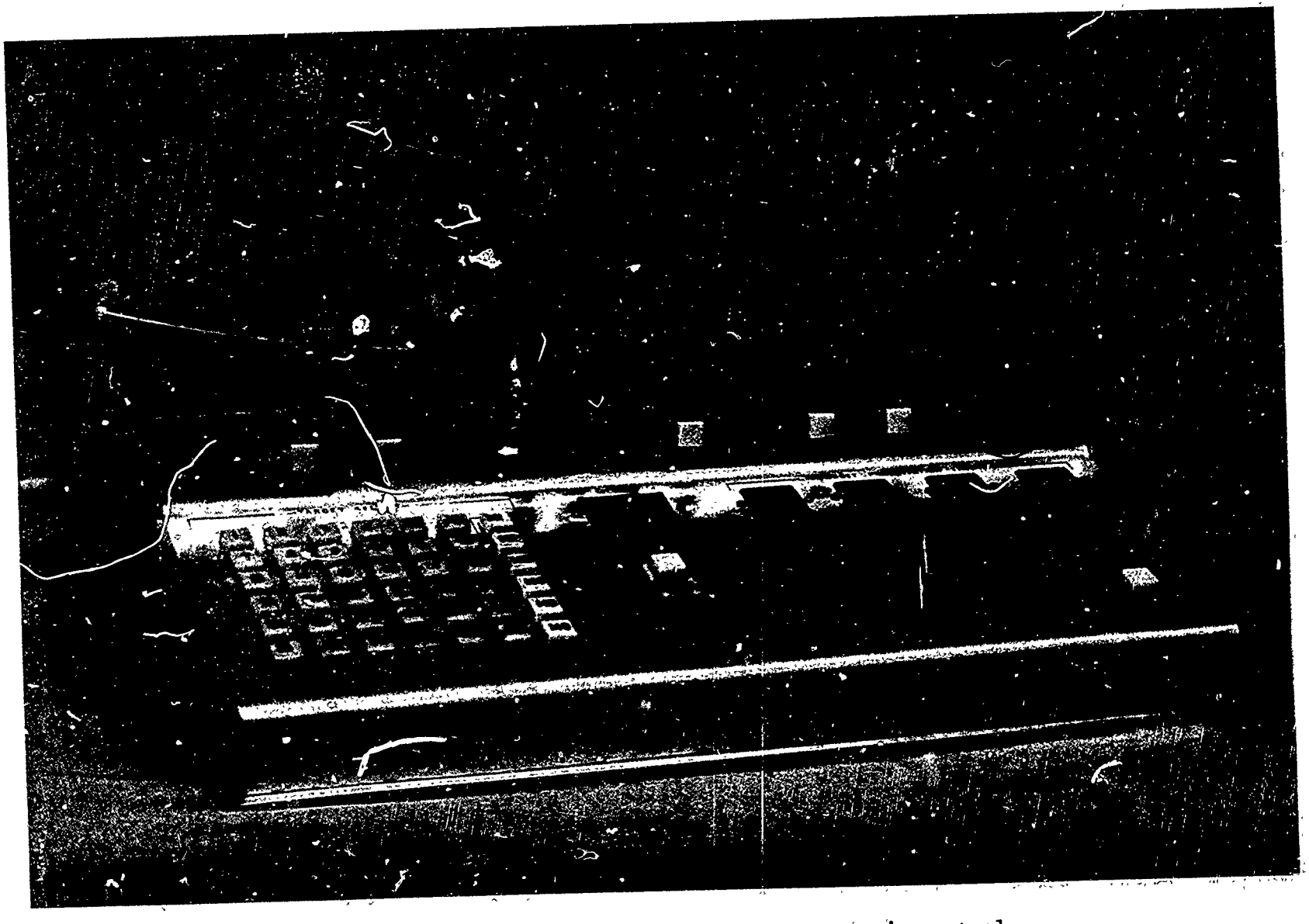

Figure 8. Pop-Up Target Data Acquisition System--operator's control console.

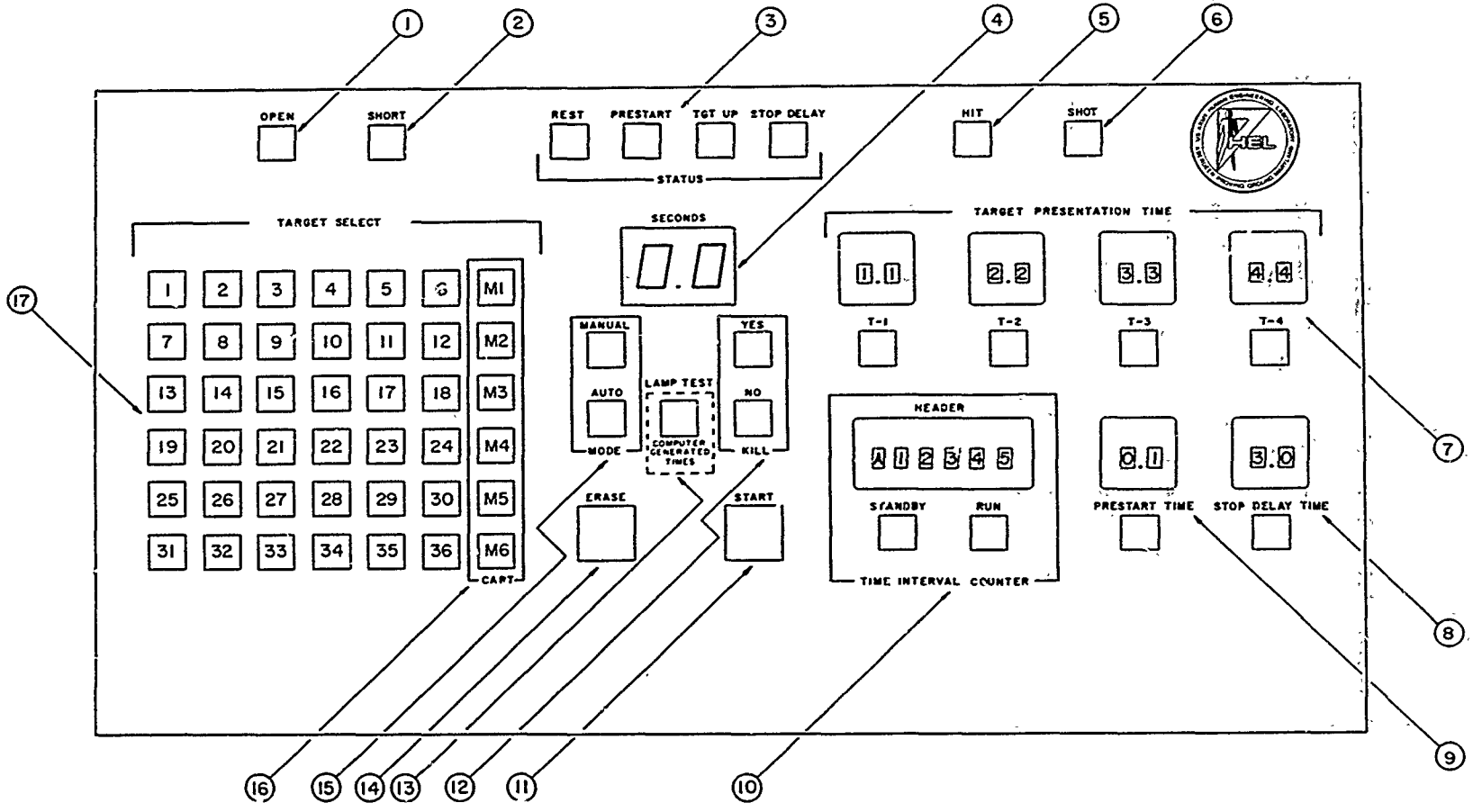

Figure 9. Operator's control console--functional description.

3 Cycle Status Indicators

Enable the operator to quickly determine the status of the controller. The status indicators illuminate sequentially from left to right when the start button is depressed.

REST - Target controller is between steps; the start button is not illuminated.

PRESTART - Indicates that the start button has been depressed but the delay time (up to 9.9 seconds) selected by Item 8 has not expired.

TGT UP - Indicates that any targets selected by Item 17 have been presented and will remain up (unless hit in KILL-YES mode) until the target presentation time selected by Item 7 has expired.

STOP DELAY - Indicates that all targets are down, but a delay equal to that selected by Item 8 has been generated. After this delay the controller returns to the rest status.

4 Time Remaining Display

Displays the time (in seconds) remaining in a given cycle of a step. Displays 0.0 when in the rest position.

5 Hit Indicator

Illuminates for approximately 100 milliseconds when a hit is detected on any target silhouette.

6 Shot Indicator

Illuminates for approximately 100 milliseconds when a shot is detected by the shot detector located at the firing point.

7 Target Presentation Time

Permits the selection (by hand or computer generated) of one of four target presentation times (T-1 through T-4) which have been entered into the appropriate thumbwheel switches. The push button switch illuminates when depressed and remains illuminated until a different switch is depressed. The target presentation time pushbuttons are only enabled when the mode selector (Item 15) is in the automatic mode.

8 Stop Delay Time

Permits the selection of a stop delay time (by hand or computer generated) which has been entered into the thumbwheel switches. The stop delay time indicator illuminates only during the stop delay cycle of a step.

9 Prestart Time

Permits the selection of a prestart time (by hand or computer generated) which has been entered into the thumbwheel switches. The prestart time indicator illuminates only during the prestart time cycle of a step.

10 Time Interval Counter

Provides remote control for the Quad Systems, Inc. Time Interval Counter located in the main electronic cabinet. The six character header thumbwheel permits the Experiment I.D. to be transmitted to the Hewlett-Packard Model 9830 Calculator when the run button is depressed. The header consists of one alpha character (A through J) followed by five numeric characters (0 through 9).

Run Pushbutton

Causes the time interval counter to reset its internal clock to zero; start the clock, accept the header information, and begin collecting event data. The run pushbutton remains illuminated until the standby pushbutton is depressed.

Standby Pushbutton

Causes the time interval counter to cease collecting event data; any data previously collected but not transmitted is lost when the standby pushbutton is depressed. The standby pushbutton remains illuminated until the run pushbutton is depressed.

11 Start Pushbutton

Causes a step to be initiated. The cycle status indicators leave the rest cycle when the start pushbutton is depressed. The pushbutton remains illuminated until the controller returns to the rest cycle.

12 Kill Yes/Kill No

Depressing the kill/yes pushbutton causes it to illuminate and causes all targets to go down when a hit is scored; depressing the kill/no pushbutton causes it to illuminate and causes all targets to remain up for the entire target up cycle even when a hit is scored.

13 Lamp Test Pushbutton

Causes all indicator lamps on the operator's control console to be illuminated.

Computer Generated Times

Indicator is illuminated when the Hewlett-Packard Model 9830 Calculator transmits a binary 223. This code causes the controller to accept cycle timing data from the calculator rather than from the Operator's Control Console. Depressing the start pushbutton (Item 11) causes the indicator to be extinguished and permits normal timing data to be entered from the console.

14 Erase Pushbutton

Causes all selected pop-up target indicators (Item 17) and moving target cart indicators (Item 16) to be extinguished. Depressing the erase pushbutton causes it to illuminate for approximately 100 milliseconds and interrupts an in-progress step.

15 Mode Select

Depressing the auto pushbutton causes it to illuminate and permits the selection of a target presentation time (Item 7); depressing the manual pushbutton causes selected targets to remain up until hit and causes the time remaining display to continually count down from 9.9 seconds. Targets which have been hit pop up every 9.9 seconds until the erase pushbutton is depressed interrupting the cycle.

16 Cart (M1 through M6)

These pushbuttons cause the selected moving target cart (future) to begin moving across the range when the controller enters the prestart cycle. The pushbutton illuminates when it is depressed and remains illuminated until extinguished by the erase pushbutton or until other targets/carts are selected for a subsequent step.

17 Pop-Up Target Select

This bank of 36 pushbuttons controls all down-range pop-up targets. Depressing one or more pushbuttons causes the appropriate indicator to illuminate continuously. The selected targets are activated when the start pushbutton is depressed. The selection of the first target in a step causes all previously activated targets to be cancelled, thereby extinguishing the appropriate indicator. Additionally, these 36 pushbuttons serve as indicators displaying the current status of the electronic silhouettes mounted on the M31A1 target mechanisms. An indicator flashing at the 1 Hertz rate signifies that an open circuit exists on the designated target silhouette (See Item 1), while an indicator flashing at a 5 Hertz rate signifies that a short circuit exists on the designated target silhouette (See Item 2).

Main Electronic Cabinet

The main electronic cabinet houses three regulated direct current (DC) power supplies which supply the following voltages necessary to operate the system:

+24 volts DC @ 5.0 amperes
+ 5 volts DC @ 12.0 amperes
- 5 volts DC @ 0.5 amperes

All power supplies operate from 105 to 125 volts AC, 50-400 Hertz. The +5 volt and +24 volt supplies are both equipped with internal preset overvoltage protectors.

The outputs of all three supplies are monitored by green indicator lamps on the front panel of the main electronic cabinet. These indicators should be illuminated whenever the power-on switch is in the on position.

The +24 volt supply provides power for the 65 indicator lamps located on the operator's control console. The +5 volt supply provides power to all TTL logic located in the main electronic cabinet, the digital display, and the electrically actuated silhouettes. The -5 volt supply provides the negative voltage required to power the operational amplifiers which form the input filter network on the target condition and shot detector cards. AC power for the system is filtered by a RFI filter as it enters the cabinet. The entire AC power distribution system is protected with a 5 ampere circuit breaker which is integrated into the power-on switch.

The card cage in the main electronics cabinet contains the wire-wrapped circuit cards which form the heart of the system. The cards are distributed as follows:

Slot Number	Card Type
1	Timing Select & Lamp Driver Card
2	Interface and Control Card
3	Target Condition Card (Tgts 1-4)
4	Target Condition Card (Tgts 5-8)
5	Target Condition Card (Tgts 9-12)
6	Target Condition Card (Tgts 13-16)
7	Target Condition Card (Tgts 17-20)
8	Target Condition Card (Tgts 21-24)
9	Target Condition Card (Tgts 25-28)
10	Target Condition Card (Tgts 29-32)
11	Target Condition Card (Tgts 33-36)
12	Shot Detector/Moving Target Card
13	Card Extender

The following paragraphs briefly describe the functional purpose of each card.

Timing Select and Lamp Driver Card

The Timing Select and Lamp Driver Card provides the logic necessary for multiplexing the six two-digit thumbwheel switches located on the operator's control console. This multiplexed data is fed to the Interface and Control Card for additional handling. Additionally, this card provides the logic and lamp drivers necessary to operate the indicators (except for Target Select and Moving Target Cart) located on the operator's control console.

Interface and Control Card

The Interface and Control Card provides the logic necessary to drive the entire controller and to interface with the Hewlett Packard Model 9830 Calculator. It contains the crystal controlled oscillator and divider circuits necessary to generate the timing pulses required to control the functions of the controller, logic necessary to cause the controller to sequence through a step (as directed by the times selected by the thumbwheel switches) raising and lowering targets, and displaying time remaining in a cycle of a step. It also contains the decoding circuitry which translates the digital codes provided by the parallel TTL Interface of the Hewlett-Packard Model 9830 Calculator into discrete commands which can duplicate any control function available on the front panel of the operator's control console. It also contains the logic which permits computer generated times to be accepted by the system in lieu of the times selected by the thumbwheel switches located on the operator's control console.

Target Condition Card

Each target condition card (there are nine identical cards) provides the input circuitry, filtering, and power necessary to operate four electrically operated hit detecting silhouettes located down-range.

Each card also handles the selection of targets to be used in a given step either manually from the operator's control console, or through digital data transmitted from the Hewlett-Packard Model 9830 Calculator.

The input circuitry and voltage comparators monitor the status of each target silhouette, instantly alerting the operator to any open or short circuits which may appear on a target silhouette line. Each input circuit also detects hits and transmits hit data to the time interval counter where it is assigned a time and temporarily stored. Each target condition card channel also contains the relays necessary to generate target up/target down signals for the M31A1 Target Holding Mechanisms.

Each card contains the logic required to selectively lower targets before the target up time has expired in a step and also the logic necessary to scan the target status (open or short) under computer control. These features have not been fully implemented in software at this time.

The nine target condition cards are fully interchangeable so as to minimize troubleshooting time.

Shot Detector/Moving Target Card

The shot detector/moving target card provides the logic necessary to detect shots fired and also necessary to cause the moving target carts (future) to begin moving across the range.

The muzzle blast of a projectile leaving the barrel of a weapon is detected by a pressure transducer[5] mounted near the muzzle of the weapon. The pulse is pre-amplified by a LAT amplifier in the detector case. This amplifier is powered by and its signal is transmitted to the card by a single RG-58/U coaxial cable. On the card, up to six pressure transducer signals are combined, amplified, and compared to predetermined threshold points. A voltage level greater than the setpoint is considered to be a valid shot. All valid shots are combined and generate a composite output pulse (approximately 18 milliseconds long) which is transmitted to the time interval counter for temporary storage. The maximum rate of fire is approximately 3000 shots per minute for short periods of time (limited by the storage capacity of the time interval counter).

This card also contains the logic necessary to cause up to six moving target carts to begin moving across the range when the controller enters the prestart portion of a step. The on-card logic generates a relay closure for the selected moving target carts. This closure interfaces with the on-cart logic to permit the cart to begin its motion.

Cart motion is independent of target silhouette activity. Therefore, in order to have a functional moving target a standard M31A1 Target Holding Mechanism is mounted upon the moving target cart.

Digital Interface

The logic contained in the card cage, on the various cards which were previously described, can all be controlled via the digital interface to the Hewlett-Packard Model 9830 Calculator. This interface permits data to be provided to the controller and also monitors the status of the current state of the controller. The hardware associated with this interface will be discussed in a later section.

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[5]Susquehanna Instruments Model ST-2, Susquehanna Instruments, Route 2, Box 228, Havre de Grace, Maryland 21078.

The following pieces of commercial hardware form the remainder of the Pop-Up Target Data Acquisition System:

Time Interval Counter

The Quad Systems, Inc., Time Interval Counter Model RC-100B is a self-contained instrument capable of operating with up to 80 independent digital inputs. The unit monitors the digital input lines, noting and recording the time of status changes.

All input channels are TTL compatible with two load units. The first 40 channels respond to plus (+) or minus (-) going level changes, while channels 41 through 80 respond only to plus (+) going level changes. The selected polarity transition is stored in an 80-bit event storage register. In this application, the entire event storage register is scanned every 10 milliseconds to detect input activity. When an event is detected on an input line, the time of occurrence, channel number, and polarity are transferred in parallel to the output data buffer. Time of occurrence is a four digit time with 10 millisecond resolution and a time base stability of $\pm$ 0.01%. The time of occurrence recycles every 100 seconds. Channel number 00 indicates clock recycle.

The output data buffer is a first-in, first-out data silo followed by an ASCII formatter. The silo capacity is 128 words (or events)[6].

A standard RS-232C compatible ASCII output is provided (with standard switch selectable baud rates from 110 through 9600).

Appendix A lists the channel number assignments for the 80 available channels on the time interval counter.

Abort Pushbutton

An abort pushbutton has been installed on the controller to interrupt data collection if necessary. This pendant pushbutton generates a channel number 79 on the time interval counter.

Hewlett-Packard Model 9830 Calculator

The Hewlett-Packard Model 9830 Programmable Calculator is a general purpose data processing system programmed in BASIC. It has 15,808 eight-bit bytes of memory and several read-only-memory (ROM) plug-in blocks which permit expanded input/output features, matrix operations, etc. The basic calculator includes a 32 character LED alphanumeric display and a built-in tape cassette which can

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[6]Quad Systems, Inc. Multi-channel Time Interval Counter System Documentation, Model RC-100B. Paragraph 1.1.

store up to 32,000 words of program or data. The Model 9866A Printer is mounted on top of the basic calculator. This printer provides a print speed of 240 lines per minute with 80 characters per line .

Hewlett-Packard Interface Cards

Communications and control is being accomplished through two interfaces to the Model 9830 Calculator.

The Time Interval Counter RS-232C output is connected to the Hewlett-Packard Model 11205A Serial Interface. This interface permits the transfer of serial ASCII coded data from a device that conforms to EIA (Electronic Industries Association) Specification RS-232C. The maximum baud rate of this interface is 1200. A clear-to-send (CTS) signal has been included in this interface so as to cause the time interval counter to transmit data only when the calculator is prepared to accept it.

The Pop-Up Target Data Acquisition System receives computer generated commands and time codes from the Hewlett-Packard Model 11202A I/O Interface. Also, the Model 11202A Interface is used to determine when the cycle status changes in a step of a scenario. This interface has an 8-bit parallel (TTL level) data structure which can either input or output data, but not both at the same time; i.e., the data transfer is half-duplex. This device provides storage for both input and output data and also has an I/O control line and ready flag line. Although the calculator handles only ASCII-coded data, the interface can transfer data in any 8-bit binary code. This interface is unusual in that it uses a "negative-true logic," i.e., less than 0.7 volts indicates 'low' or logic '1' or 'true', and greater than 2.4 volts indicates 'high' or logic '0' or 'false'.[8]

Appendix B shows the code conversion which was necessary to utilize the negative-true logic of the Hewlett-Packard Model 11202A I/O Interface.

Software

Software for the Pop-Target Data Acquisition System consists of BASIC language programs written for the Hewlett-Packard Model 9830 Desktop Calculator. Various programs have been written including those that only collect and reduce data and also those that fully operate the range (raising and lowering targets).

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[7]Hewlett-Packard Co, Inc. 1975 Electronic Instruments and Systems Catalog. Palo Alto, CA, 1974, p. 535.

[8]Hewlett-Packard Co, Inc. 11202A I/O Interface Installation and Service Manual. Loveland, Colorado, 1974, p. 1-2.

Appendix C shows the flowchart for a typical BASIC program which was written to enable the Pop-Up Target Data Acquisition System to present a 20-step scenario which repeats a four-step sequence five times: targets 17, 18 and 19 are presented sequentially followed by all three targets presented simultaneously. Intertarget times are controlled by the operator's control console thumbwheel switches, but target presentation times (T-1 or T-2) are software controlled.

Target and control selection uses data which were obtained from the code conversions shown in Appendix B.

This program provides a step by step output showing the step number, time the step started (in seconds, referenced to an arbitrary starting time), number of shots fired and time of each shot, number of hits, and time of each hit (if any). Each shot or hit time is referenced to the arbitrary starting time. Additionally, a tabular output is provided for each step. This output provides data in six columns: Target Number, Target Up Time, Target Exposure Time, First Hit Time, Number of Hits, and Acquisition Time. One line of data is generated for each active target in a step. At the end of the 20-step scenario, a recapitulation is provided which indicates subject identification, total number of shots fired, total number of hits scored, and percentage of shots that scored hits.

This typical software can be modified to provide whatever level of control or flexibility is desired to just collect data or to fully operate the range. Once the raw data has been obtained, it can easily be manipulated to provide whatever data the test director desires.

Future improvements to the software capabilities of the data acquisition system call for the installation of an editor which will permit someone with minimal programming experience to generate the data necessary to fully operate the range under computer control. Future software will also permit the detection of defective target silhouettes (open and short circuits) utilizing the existing hardware.

SUMMARY

The "M" Range Pop-Up Target Test Facility provides the US Army Human Engineering Laboratory with a flexible data collection facility which has been extensively used to evaluate soldier's performance in all areas of small arms weapons. This facility is continually being improved and updated to increase its reliability and flexibility.

APPENDIX A

TIME INTERVAL COUNTER CHANNEL NUMBER ASSIGNMENTS

APPENDIX A

TIME INTERVAL COUNTER CHANNEL NUMBER ASSIGNMENTS

CHAN. #	+/-	FUNCTION	CHAN. #	+/-	FUNCTION
1	+	Target #1 - UP	19	+	Target #19 - UP
1	-	Target #1 - DOWN	19	-	Target #19 - DOWN
2	+	Target #2 - UP	20	+	Target #20 - UP
2	-	Target #2 - DOWN	20	-	Target #20 - DOWN
3	+	Target #3 - UP	21	+	Target #21 - UP
3	-	Target #3 - DOWN	21	-	Target #21 - DOWN
4	+	Target #4 - UP	22	+	Target #22 - UP
4	-	Target #4 - DOWN	22	-	Target #22 - DOWN
5	+	Target #5 - UP	23	+	Target #23 - UP
5	-	Target #5 - DOWN	23	-	Target #23 - DOWN
6	+	Target #6 - UP	24	+	Target #24 - UP
6	-	Target #6 - DOWN	24	-	Target #24 - DOWN
7	+	Target #7 - UP	25	+	Target #25 - UP
7	-	Target #7 - DOWN	25	-	Target #25 - DOWN
8	+	Target #8 - UP	26	+	Target #26 - UP
8	-	Target #8 - DOWN	26	-	Target #26 - DOWN
9	+	Target #9 - UP	27	+	Target #27 - UP
9	-	Target #9 - DOWN	27	-	Target #27 - DOWN
10	+	Target #10 - UP	28	+	Target #28 - UP
10	-	Target #10 - DOWN	28	-	Target #28 - DOWN
11	+	Target #11 - UP	29	+	Target #29 - UP
11	-	Target #11 - DOWN	29	-	Target #29 - DOWN
12	+	Target #12 - UP	30	+	Target #30 - UP
12	-	Target #12 - DOWN	30	-	Target #30 - DOWN
13	+	Target #13 - UP	31	+	Target #31 - UP
13	-	Target #13 - DOWN	31	-	Target #31 - DOWN
14	+	Target #14 - UP	32	+	Target #32 - UP
14	-	Target #14 - DOWN	32	-	Target #32 - DOWN
15	+	Target #15 - UP	33	+	Target #33 - UP
15	-	Target #15 - DOWN	33	-	Target #33 - DOWN
16	+	Target #16 - UP	34	+	Target #34 - UP
16	-	Target #16 - DOWN	34	-	Target #34 - DOWN
17	+	Target #17 - UP	35	+	Target #35 - UP
17	-	Target #17 - DOWN	35	-	Target #35 - DOWN
18	+	Target #18 - UP	36	+	Target #36 - UP
18	-	Target #18 - DOWN	36	-	Target #36 - DOWN

CHAN. #	+/-	FUNCTION	CHAN. #	+/-	FUNCTION
39	+	Enter Tgt Up Mode	58	+	Target #18 - HIT
39	-	Leave Tgt Up Mode	59	+	Target #19 - HIT
40	+	Enter Rest Mode	60	+	Target #20 - HIT
40	-	Leave Rest Mode	61	+	Target #21 - HIT
41	+	Target #1 - HIT	62	+	Target #22 - HIT
42	+	Target #2 - HIT	63	+	Target #23 - HIT
43	+	Target #3 - HIT	64	+	Target #24 - HIT
44	+	Target #4 - HIT	65	+	Target #25 - HIT
45	+	Target #5 - HIT	66	+	Target #26 - HIT
46	+	Target #6 - HIT	67	+	Target #27 - HIT
47	+	Target #7 - HIT	68	+	Target #28 - HIT
48	+	Target #8 - HIT	69	+	Target #29 - HIT
49	+	Target #9 - HIT	70	+	Target #30 - HIT
50	+	Target #10 - HIT	71	+	Target #31 - HIT
51	+	Target #11 - HIT	72	+	Target #32 - HIT
52	+	Target #12 - HIT	73	+	Target #33 - HIT
53	+	Target #13 - HIT	74	+	Target #34 - HIT
54	+	Target #14 - HIT	75	+	Target #35 - HIT
55	+	Target #15 - HIT	76	+	Target #36 - HIT
56	+	Target #16 - HIT	79	+	Abort
57	+	Target #17 - HIT	80	+	Shot Detected

STANDARD OUTPUT FORMAT: HEADER - LXXXXX CR LF
DATA - CC,STTTT CR LF

L = LETTER (A THRU J)
X = I.D.DIGIT (0 THRU 9)
CR = CARRIAGE RETURN
LF = LINE FEED
S = SIGN (+ OR -)
C = CHANNEL NUMBER DIGIT (00 THRU 80)
T = TIME DIGIT (0 THRU 9)
TIME + 00.00 SECS THRU 99.99 SECS WITH REPEAT
00, +0000 = TIME REPEAT

APPENDIX B

CODE CONVERSION: TARGET CONTROLLER TO HP-9830 PARALLEL INTERFACE

APPENDIX B

CODE CONVERSION: TARGET CONTROLLER TO HP-9830 PARALLEL INTERFACE

	POSITIVE TRUE LOGIC	H-P NEGATIVE TRUE LOGIC	
DECIMAL	BINARY	BINARY	DECIMAL
0	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1	255
1	0 0 0 0 0 0 0 1	1 1 1 1 1 1 1 0	254
2	0 0 0 0 0 0 1 0	1 1 1 1 1 1 0 1	253
3	0 0 0 0 0 0 1 1	1 1 1 1 1 1 0 0	252
4	0 0 0 0 0 1 0 0	1 1 1 1 1 0 1 1	251
5	0 0 0 0 0 1 0 1	1 1 1 1 1 0 1 0	250
6	0 0 0 0 0 1 1 0	1 1 1 1 1 0 0 1	249
7	0 0 0 0 0 1 1 1	1 1 1 1 1 0 0 0	248
8	0 0 0 0 1 0 0 0	1 1 1 1 0 1 1 1	247
9	0 0 0 0 1 0 0 1	1 1 1 1 0 1 1 0	246
10	0 0 0 0 1 0 1 0	1 1 1 1 0 1 0 1	245
11	0 0 0 0 1 0 1 1	1 1 1 1 0 1 0 0	244
12	0 0 0 0 1 1 0 0	1 1 1 1 0 0 1 1	243
13	0 0 0 0 1 1 0 1	1 1 1 1 0 0 1 0	242
14	0 0 0 0 1 1 1 0	1 1 1 1 0 0 0 1	241
15	0 0 0 0 1 1 1 1	1 1 1 1 0 0 0 0	240
16	0 0 0 1 0 0 0 0	1 1 1 0 1 1 1 1	239
17	0 0 0 1 0 0 0 1	1 1 1 0 1 1 1 0	238
18	0 0 0 1 0 0 1 0	1 1 1 0 1 1 0 1	237
19	0 0 0 1 0 0 1 1	1 1 1 0 1 1 0 0	236
20	0 0 0 1 0 1 0 0	1 1 1 0 1 0 1 1	235
21	0 0 0 1 0 1 0 1	1 1 1 0 1 0 1 0	234
22	0 0 0 1 0 1 1 0	1 1 1 0 1 0 0 1	233
23	0 0 0 1 0 1 1 1	1 1 1 0 1 0 0 0	232
24	0 0 0 1 1 0 0 0	1 1 1 0 0 1 1 1	231
25	0 0 0 1 1 0 0 1	1 1 1 0 0 1 1 0	230
26	0 0 0 1 1 0 1 0	1 1 1 0 0 1 0 1	229
27	0 0 0 1 1 0 1 1	1 1 1 0 0 1 0 0	228
28	0 0 0 1 1 1 0 0	1 1 1 0 0 0 1 1	227
29	0 0 0 1 1 1 0 1	1 1 1 0 0 0 1 0	226
30	0 0 0 1 1 1 1 0	1 1 1 0 0 0 0 1	225
31	0 0 0 1 1 1 1 1	1 1 1 0 0 0 0 0	224
32	0 0 1 0 0 0 0 0	1 1 0 1 1 1 1 1	223
33	0 0 1 0 0 0 0 1	1 1 0 1 1 1 1 0	222
34	0 0 1 0 0 0 1 0	1 1 0 1 1 1 0 1	221
35	0 0 1 0 0 0 1 1	1 1 0 1 1 1 0 0	220
36	0 0 1 0 0 1 0 0	1 1 0 1 1 0 1 1	219
37	0 0 1 0 0 1 0 1	1 1 0 1 1 0 1 0	218
38	0 0 1 0 0 1 1 0	1 1 0 1 1 0 0 1	217
39	0 0 1 0 0 1 1 1	1 1 0 1 1 0 0 0	216
40	0 0 1 0 1 0 0 0	1 1 0 1 0 1 1 1	215
41	0 0 1 0 1 0 0 1	1 1 0 1 0 1 1 0	214
42	0 0 1 0 1 0 1 0	1 1 0 1 0 1 0 1	213
43	0 0 1 0 1 0 1 1	1 1 0 1 0 1 0 0	212
44	0 0 1 0 1 1 0 0	1 1 0 1 0 0 1 1	211

CODE CONVERSION: TARGET CONTROLLER TO HP-9830 PARALLEL INTERFACE

POSITIVE TRUE LOGIC		H-P NEGATIVE TRUE LOGIC	
DECIMAL	BINARY	BINARY	DECIMAL
45	0 0 1 0 1 1 0 1	1 1 0 1 0 0 1 0	210
46	0 0 1 0 1 1 1 0	1 1 0 1 0 0 0 1	209
47	0 0 1 0 1 1 1 1	1 1 0 1 0 0 0 0	208
48	0 0 1 1 0 0 0 0	1 1 0 0 1 1 1 1	207
49	0 0 1 1 0 0 0 1	1 1 0 0 1 1 1 0	206
50	0 0 1 1 0 0 1 0	1 1 0 0 1 1 0 1	205
51	0 0 1 1 0 0 1 1	1 1 0 0 1 1 0 0	204
52	0 0 1 1 0 1 0 0	1 1 0 0 1 0 1 1	203
53	0 0 1 1 0 1 0 1	1 1 0 0 1 0 1 0	202
54	0 0 1 1 0 1 1 0	1 1 0 0 1 0 0 1	201
55	0 0 1 1 0 1 1 1	1 1 0 0 1 0 0 0	200
56	0 0 1 1 1 0 0 0	1 1 0 0 0 1 1 1	199
57	0 0 1 1 1 0 0 1	1 1 0 0 0 1 1 0	198
58	0 0 1 1 1 0 1 0	1 1 0 0 0 1 0 1	197
59	0 0 1 1 1 0 1 1	1 1 0 0 0 1 0 0	196
60	0 0 1 1 1 1 0 0	1 1 0 0 0 0 1 1	195
61	0 0 1 1 1 1 0 1	1 1 0 0 0 0 1 0	194
62	0 0 1 1 1 1 1 0	1 1 0 0 0 0 0 1	193
63	0 0 1 1 1 1 1 1	1 1 0 0 0 0 0 0	192
64	0 1 0 0 0 0 0 0	1 0 1 1 1 1 1 1	191
65	0 1 0 0 0 0 0 1	1 0 1 1 1 1 1 0	190
66	0 1 0 0 0 0 1 0	1 0 1 1 1 1 0 1	189
67	0 1 0 0 0 0 1 1	1 0 1 1 1 1 0 0	188
68	0 1 0 0 0 1 0 0	1 0 1 1 1 0 1 1	187
69	0 1 0 0 0 1 0 1	1 0 1 1 1 0 1 0	186
70	0 1 0 0 0 1 1 0	1 0 1 1 1 0 0 1	185
71	0 1 0 0 0 1 1 1	1 0 1 1 1 0 0 0	184
72	0 1 0 0 1 0 0 0	1 0 1 1 0 1 1 1	183
73	0 1 0 0 1 0 0 1	1 0 1 1 0 1 1 0	182
74	0 1 0 0 1 0 1 0	1 0 1 1 0 1 0 1	181
75	0 1 0 0 1 0 1 1	1 0 1 1 0 1 0 0	180
76	0 1 0 0 1 1 0 0	1 0 1 1 0 0 1 1	179
77	0 1 0 0 1 1 0 1	1 0 1 1 0 0 1 0	178
78	0 1 0 0 1 1 1 0	1 0 1 1 0 0 0 1	177
79	0 1 0 0 1 1 1 1	1 0 1 1 0 0 0 0	176
80	0 1 0 1 0 0 0 0	1 0 1 0 1 1 1 1	175
81	0 1 0 1 0 0 0 1	1 0 1 0 1 1 1 0	174
82	0 1 0 1 0 0 1 0	1 0 1 0 1 1 0 1	173
83	0 1 0 1 0 0 1 1	1 0 1 0 1 1 0 0	172
84	0 1 0 1 0 1 0 0	1 0 1 0 1 0 1 1	171
85	0 1 0 1 0 1 0 1	1 0 1 0 1 0 1 0	170

CODE CONVERSION: TARGET CONTROLLER TO HP-9830 PARALLEL INTERFACE

POSITIVE TRUE LOGIC		H-P NEGATIVE TRUE LOGIC	
DECIMAL	BINARY	BINARY	DECIMAL
86	0 1 0 1 0 1 1 0	1 0 1 0 1 0 0 1	169
87	0 1 0 1 0 1 1 1	1 0 1 0 1 0 0 0	168
88	0 1 0 1 1 0 0 0	1 0 1 0 0 1 1 1	167
89	0 1 0 1 1 0 0 1	1 0 1 0 0 1 1 0	166
90	0 1 0 1 1 0 1 0	1 0 1 0 0 1 0 1	165
91	0 1 0 1 1 0 1 1	1 0 1 0 0 1 0 0	164
92	0 1 0 1 1 1 0 0	1 0 1 0 0 0 1 1	163
93	0 1 0 1 1 1 0 1	1 0 1 0 0 0 1 0	162
94	0 1 0 1 1 1 1 0	1 0 1 0 0 0 0 1	161
95	0 1 0 1 1 1 1 1	1 0 1 0 0 0 0 0	160
96	0 1 1 0 0 0 0 0	1 0 0 1 1 1 1 1	159
97	0 1 1 0 0 0 0 1	1 0 0 1 1 1 1 0	158
98	0 1 1 0 0 0 1 0	1 0 0 1 1 1 0 1	157
99	0 1 1 0 0 0 1 1	1 0 0 1 1 1 0 0	156
100	0 1 1 0 0 1 0 0	1 0 0 1 1 0 1 1	155
101	0 1 1 0 0 1 0 1	1 0 0 1 1 0 1 0	154
102	0 1 1 0 0 1 1 0	1 0 0 1 1 0 0 1	153
103	0 1 1 0 0 1 1 1	1 0 0 1 1 0 0 0	152
104	0 1 1 0 1 0 0 0	1 0 0 1 0 1 1 1	151
105	0 1 1 0 1 0 0 1	1 0 0 1 0 1 1 0	150
106	0 1 1 0 1 0 1 0	1 0 0 1 0 1 0 1	149
107	0 1 1 0 1 0 1 1	1 0 0 1 0 1 0 0	148
108	0 1 1 0 1 1 0 0	1 0 0 1 0 0 1 1	147
109	0 1 1 0 1 1 0 1	1 0 0 1 0 0 1 0	146
110	0 1 1 0 1 1 1 0	1 0 0 1 0 0 0 1	145
111	0 1 1 0 1 1 1 1	1 0 0 1 0 0 0 0	144
112	0 1 1 1 0 0 0 0	1 0 0 0 1 1 1 1	143
113	0 1 1 1 0 0 0 1	1 0 0 0 1 1 1 0	142
114	0 1 1 1 0 0 1 0	1 0 0 0 1 1 0 1	141
115	0 1 1 1 0 0 1 1	1 0 0 0 1 1 0 0	140
116	0 1 1 1 0 1 0 0	1 0 0 0 1 0 1 1	139
117	0 1 1 1 0 1 0 1	1 0 0 0 1 0 1 0	138
118	0 1 1 1 0 1 1 0	1 0 0 0 1 0 0 1	137
119	0 1 1 1 0 1 1 1	1 0 0 0 1 0 0 0	136
120	0 1 1 1 1 0 0 0	1 0 0 0 0 1 1 1	135
121	0 1 1 1 1 0 0 1	1 0 0 0 0 1 1 0	134
122	0 1 1 1 1 0 1 0	1 0 0 0 0 1 0 1	133
123	0 1 1 1 1 0 1 1	1 0 0 0 0 1 0 0	132
124	0 1 1 1 1 1 0 0	1 0 0 0 0 0 1 1	131
125	0 1 1 1 1 1 0 1	1 0 0 0 0 0 1 0	130
126	0 1 1 1 1 1 1 0	1 0 0 0 0 0 0 1	129
127	0 1 1 1 1 1 1 1	1 0 0 0 0 0 0 0	128
128	1 0 0 0 0 0 0 0	0 1 1 1 1 1 1 1	127
129	1 0 0 0 0 0 0 1	0 1 1 1 1 1 1 0	126

CODE CONVERSION: TARGET CONTROLLER TO HP-9830 PARALLEL INTERFACE

POSITIVE TRUE LOGIC		H-P NEGATIVE TRUE LOGIC	
DECIMAL	BINARY	BINARY	DECIMAL
130	1 0 0 0 0 0 1 0	0 1 1 1 1 1 0 1	125
131	1 0 0 0 0 0 1 1	0 1 1 1 1 1 0 0	124
132	1 0 0 0 0 1 0 0	0 1 1 1 1 0 1 1	123
133	1 0 0 0 0 1 0 1	0 1 1 1 1 0 1 0	122
134	1 0 0 0 0 1 1 0	0 1 1 1 1 0 0 1	121
135	1 0 0 0 0 1 1 1	0 1 1 1 1 0 0 0	120
136	1 0 0 0 1 0 0 0	0 1 1 1 0 1 1 1	119
137	1 0 0 0 1 0 0 1	0 1 1 1 0 1 1 0	118
138	1 0 0 0 1 0 1 0	0 1 1 1 0 1 0 1	117
139	1 0 0 0 1 0 1 1	0 1 1 1 0 1 0 0	116
140	1 0 0 0 1 1 0 0	0 1 1 1 0 0 1 1	115
141	1 0 0 0 1 1 0 1	0 1 1 1 0 0 1 0	114
142	1 0 0 0 1 1 1 0	0 1 1 1 0 0 0 1	113
143	1 0 0 0 1 1 1 1	0 1 1 1 0 0 0 0	112
144	1 0 0 1 0 0 0 0	0 1 1 0 1 1 1 1	111
145	1 0 0 1 0 0 0 1	0 1 1 0 1 1 1 0	110
146	1 0 0 1 0 0 1 0	0 1 1 0 1 1 0 1	109
147	1 0 0 1 0 0 1 1	0 1 1 0 1 1 0 0	108
148	1 0 0 1 0 1 0 0	0 1 1 0 1 0 1 1	107
149	1 0 0 1 0 1 0 1	0 1 1 0 1 0 1 0	106
150	1 0 0 1 0 1 1 0	0 1 1 0 1 0 0 1	105
151	1 0 0 1 0 1 1 1	0 1 1 0 1 0 0 0	104
152	1 0 0 1 1 0 0 0	0 1 1 0 0 1 1 1	103
153	1 0 0 1 1 0 0 1	0 1 1 0 0 1 1 0	102
154	1 0 0 1 1 0 1 0	0 1 1 0 0 1 0 1	101
155	1 0 0 1 1 0 1 1	0 1 1 0 0 1 0 0	100
156	1 0 0 1 1 1 0 0	0 1 1 0 0 0 1 1	99
157	1 0 0 1 1 1 0 1	0 1 1 0 0 0 1 0	98
158	1 0 0 1 1 1 1 0	0 1 1 0 0 0 0 1	97
159	1 0 0 1 1 1 1 1	0 1 1 0 0 0 0 0	96
160	1 0 1 0 0 0 0 0	0 1 0 1 1 1 1 1	95
161	1 0 1 0 0 0 0 1	0 1 0 1 1 1 1 0	94
162	1 0 1 0 0 0 1 0	0 1 0 1 1 1 0 1	93
163	1 0 1 0 0 0 1 1	0 1 0 1 1 1 0 0	92
164	1 0 1 0 0 1 0 0	0 1 0 1 1 0 1 1	91
165	1 0 1 0 0 1 0 1	0 1 0 1 1 0 1 0	90
166	1 0 1 0 0 1 1 0	0 1 0 1 1 0 0 1	89
167	1 0 1 0 0 1 1 1	0 1 0 1 1 0 0 0	88
168	1 0 1 0 1 0 0 0	0 1 0 1 0 1 1 1	87
169	1 0 1 0 1 0 0 1	0 1 0 1 0 1 1 0	86
170	1 0 1 0 1 0 1 0	0 1 0 1 0 1 0 1	85
171	1 0 1 0 1 0 1 1	0 1 0 1 0 1 0 0	84
172	1 0 1 0 1 1 0 0	0 1 0 1 0 0 1 1	83
173	1 0 1 0 1 1 0 1	0 1 0 1 0 0 1 0	82
174	1 0 1 0 1 1 1 0	0 1 0 1 0 0 0 1	81

CODE CONVERSION: TARGET CONTROLLER TO HP-9830 PARALLEL INTERFACE

POSITIVE TRUE LOGIC		H-P NEGATIVE TRUE LOGIC	
DECIMAL	BINARY	BINARY	DECIMAL
175	1 0 1 0 1 1 1 1	0 1 0 1 0 0 0 0	80
176	1 0 1 1 0 0 0 0	0 1 0 0 1 1 1 1	79
177	1 0 1 1 0 0 0 1	0 1 0 0 1 1 1 0	78
178	1 0 1 1 0 0 1 0	0 1 0 0 1 1 0 1	77
179	1 0 1 1 0 0 1 1	0 1 0 0 1 1 0 0	76
180	1 0 1 1 0 1 0 0	0 1 0 0 1 0 1 1	75
181	1 0 1 1 0 1 0 1	0 1 0 0 1 0 1 0	74
182	1 0 1 1 0 1 1 0	0 1 0 0 1 0 0 1	73
183	1 0 1 1 0 1 1 1	0 1 0 0 1 0 0 0	72
184	1 0 1 1 1 0 0 0	0 1 0 0 0 1 1 1	71
185	1 0 1 1 1 0 0 1	0 1 0 0 0 1 1 0	70
186	1 0 1 1 1 0 1 0	0 1 0 0 0 1 0 1	69
187	1 0 1 1 1 0 1 1	0 1 0 0 0 1 0 0	68
188	1 0 1 1 1 1 0 0	0 1 0 0 0 0 1 1	67
189	1 0 1 1 1 1 0 1	0 1 0 0 0 0 1 0	66
190	1 0 1 1 1 1 1 0	0 1 0 0 0 0 0 1	65
191	1 0 1 1 1 1 1 1	0 1 0 0 0 0 0 0	64
192	1 1 0 0 0 0 0 0	0 0 1 1 1 1 1 1	63
193	1 1 0 0 0 0 0 1	0 0 1 1 1 1 1 0	62
194	1 1 0 0 0 0 1 0	0 0 1 1 1 1 0 1	61
195	1 1 0 0 0 0 1 1	0 0 1 1 1 1 0 0	60
196	1 1 0 0 0 1 0 0	0 0 1 1 1 0 1 1	59
197	1 1 0 0 0 1 0 1	0 0 1 1 1 0 1 0	58
198	1 1 0 0 0 1 1 0	0 0 1 1 1 0 0 1	57
199	1 1 0 0 0 1 1 1	0 0 1 1 1 0 0 0	56
200	1 1 0 0 1 0 0 0	0 0 1 1 0 1 1 1	55
201	1 1 0 0 1 0 0 1	0 0 1 1 0 1 1 0	54
202	1 1 0 0 1 0 1 0	0 0 1 1 0 1 0 1	53
203	1 1 0 0 1 0 1 1	0 0 1 1 0 1 0 0	52
204	1 1 0 0 1 1 0 0	0 0 1 1 0 0 1 1	51
205	1 1 0 0 1 1 0 1	0 0 1 1 0 0 1 0	50
206	1 1 0 0 1 1 1 0	0 0 1 1 0 0 0 1	49
207	1 1 0 0 1 1 1 1	0 0 1 1 0 0 0 0	48
208	1 1 0 1 0 0 0 0	0 0 1 0 1 1 1 1	47
209	1 1 0 1 0 0 0 1	0 0 1 0 1 1 1 0	46
210	1 1 0 1 0 0 1 0	0 0 1 0 1 1 0 1	45
211	1 1 0 1 0 0 1 1	0 0 1 0 1 1 0 0	44
212	1 1 0 1 0 1 0 0	0 0 1 0 1 0 1 1	43
213	1 1 0 1 0 1 0 1	0 0 1 0 1 0 1 0	42
214	1 1 0 1 0 1 1 0	0 0 1 0 1 0 0 1	41
215	1 1 0 1 0 1 1 1	0 0 1 0 1 0 0 0	40
216	1 1 0 1 1 0 0 0	0 0 1 0 0 1 1 1	39
217	1 1 0 1 1 0 0 1	0 0 1 0 0 1 1 0	38
218	1 1 0 1 1 0 1 0	0 0 1 0 0 1 0 1	37
219	1 1 0 1 1 0 1 1	0 0 1 0 0 1 0 0	36

CODE CONVERSION: TARGET CONTROLLER TO HP-9830 PARALLEL INTERFACE

POSITIVE TRUE LOGIC		H-P NEGATIVE TRUE LOGIC	
DECIMAL	BINARY	BINARY	DECIMAL
220	1 1 0 1 1 1 0 0	0 0 1 0 0 0 1 1	35
221	1 1 0 1 1 1 0 1	0 0 1 0 0 0 1 0	34
222	1 1 0 1 1 1 1 0	0 0 1 0 0 0 0 1	33
223	1 1 0 1 1 1 1 1	0 0 1 0 0 0 0 0	32
224	1 1 1 0 0 0 0 0	0 0 0 1 1 1 1 1	31
225	1 1 1 0 0 0 0 1	0 0 0 1 1 1 1 0	30
226	1 1 1 0 0 0 1 0	0 0 0 1 1 1 0 1	29
227	1 1 1 0 0 0 1 1	0 0 0 1 1 1 0 0	28
228	1 1 1 0 0 1 0 0	0 0 0 1 1 0 1 1	27
229	1 1 1 0 0 1 0 1	0 0 0 1 1 0 1 0	26
230	1 1 1 0 0 1 1 0	0 0 0 1 1 0 0 1	25
231	1 1 1 0 0 1 1 1	0 0 0 1 1 0 0 0	24
232	1 1 1 0 1 0 0 0	0 0 0 1 0 1 1 1	23
233	1 1 1 0 1 0 0 1	0 0 0 1 0 1 1 0	22
234	1 1 1 0 1 0 1 0	0 0 0 1 0 1 0 1	21
235	1 1 1 0 1 0 1 1	0 0 0 1 0 1 0 0	20
236	1 1 1 0 1 1 0 0	0 0 0 1 0 0 1 1	19
237	1 1 1 0 1 1 0 1	0 0 0 1 0 0 1 0	18
238	1 1 1 0 1 1 1 0	0 0 0 1 0 0 0 1	17
239	1 1 1 0 1 1 1 1	0 0 0 1 0 0 0 0	16
240	1 1 1 1 0 0 0 0	0 0 0 0 1 1 1 1	15
241	1 1 1 1 0 0 0 1	0 0 0 0 1 1 1 0	14
242	1 1 1 1 0 0 1 0	0 0 0 0 1 1 0 1	13
243	1 1 1 1 0 0 1 1	0 0 0 0 1 1 0 0	12
244	1 1 1 1 0 1 0 0	0 0 0 0 1 0 1 1	11
245	1 1 1 1 0 1 0 1	0 0 0 0 1 0 1 0	10
246	1 1 1 1 0 1 1 0	0 0 0 0 1 0 0 1	9
247	1 1 1 1 0 1 1 1	0 0 0 0 1 0 0 0	8
248	1 1 1 1 1 0 0 0	0 0 0 0 0 1 1 1	7
249	1 1 1 1 1 0 0 1	0 0 0 0 0 1 1 0	6
250	1 1 1 1 1 0 1 0	0 0 0 0 0 1 0 1	5
251	1 1 1 1 1 0 1 1	0 0 0 0 0 0 1 0	4
252	1 1 1 1 1 1 0 0	0 0 0 0 0 0 1 1	3
253	1 1 1 1 1 1 0 1	0 0 0 0 0 0 1 0	2
254	1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 1	1
255	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0	0

TARGET SELECT, DOWN, & STATUS CODE CONVERSIONS TO HP-9830 DECIMAL CODE

HP-9830 CODE (DECIMAL)

TARGET NUMBER	TARGET SELECT	TARGET DOWN	TARGET STATUS
1	195	67	131
2	194	66	130
3	193	65	129
4	192	64	128
5	199	71	135
6	198	70	134
7	197	69	133
8	196	68	132
9	203	75	139
10	202	74	138
11	201	73	137
12	200	72	136
13	207	79	143
14	206	78	142
15	205	77	141
16	204	76	140
17	211	83	147
18	210	82	146
19	209	81	145
20	208	80	144
21	215	87	151
22	214	86	150
23	213	85	149
24	212	84	148
25	231	103	167
26	230	102	166
27	229	101	165
28	228	100	164
29	235	107	171
30	234	106	170
31	233	105	169
32	232	104	168
33	239	111	175
34	238	110	174
35	237	109	173
36	236	108	172

TIME CODE CONVERSIONS TO HP-9830 DECIMAL CODES

TIME (SECS)	H-P CODE (DECIMAL)	TIME (SECS)	H-P CODE (DECIMAL)
0.0	255	3.0	207
0.1	254	3.1	206
0.2	253	3.2	205
0.3	252	3.3	204
0.4	251	3.4	203
0.5	250	3.5	202
0.6	249	3.6	201
0.7	248	3.7	200
0.8	247	3.8	199
0.9	246	3.9	198
1.0	239	4.0	191
1.1	238	4.1	190
1.2	237	4.2	189
1.3	236	4.3	188
1.4	235	4.4	187
1.5	234	4.5	186
1.6	233	4.6	185
1.7	232	4.7	184
1.8	231	4.8	183
1.9	230	4.9	182
2.0	223	5.0	175
2.1	222	5.1	174
2.2	221	5.2	173
2.3	220	5.3	172
2.4	219	5.4	171
2.5	218	5.5	170
2.6	217	5.6	169
2.7	216	5.7	168
2.8	215	5.8	167
2.9	214	5.9	166

TIME CODE CONVERSIONS TO HP-9830 DECIMAL CODES

TIME (SECS)	H-P CODE (DECIMAL)	TIME (SECS)	H-P CODE (DECIMAL)
6.0	159	8.0	127
6.1	158	8.1	126
6.2	157	8.2	125
6.3	156	8.3	124
6.4	155	8.4	123
6.5	154	8.5	122
6.6	153	8.6	121
6.7	152	8.7	120
6.8	151	8.8	119
6.9	150	8.9	118
7.0	143	9.0	111
7.1	142	9.1	110
7.2	141	9.2	109
7.3	140	9.3	108
7.4	139	9.4	107
7.5	138	9.5	106
7.6	137	9.6	105
7.7	136	9.7	104
7.8	135	9.8	103
7.9	134	9.9	102

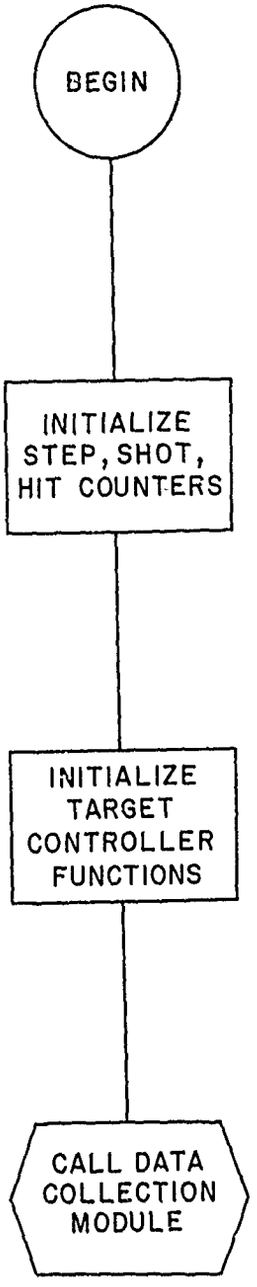
OPERATOR'S CONTROL CONSOLE SWITCH FUNCTIONS

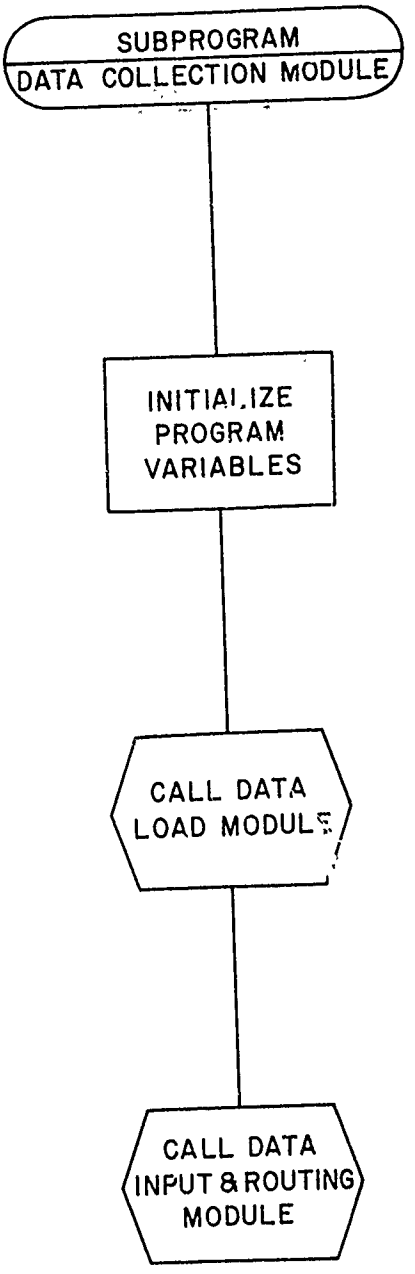
CODE CONVERSION TO HP 9830 DECIMAL CODE

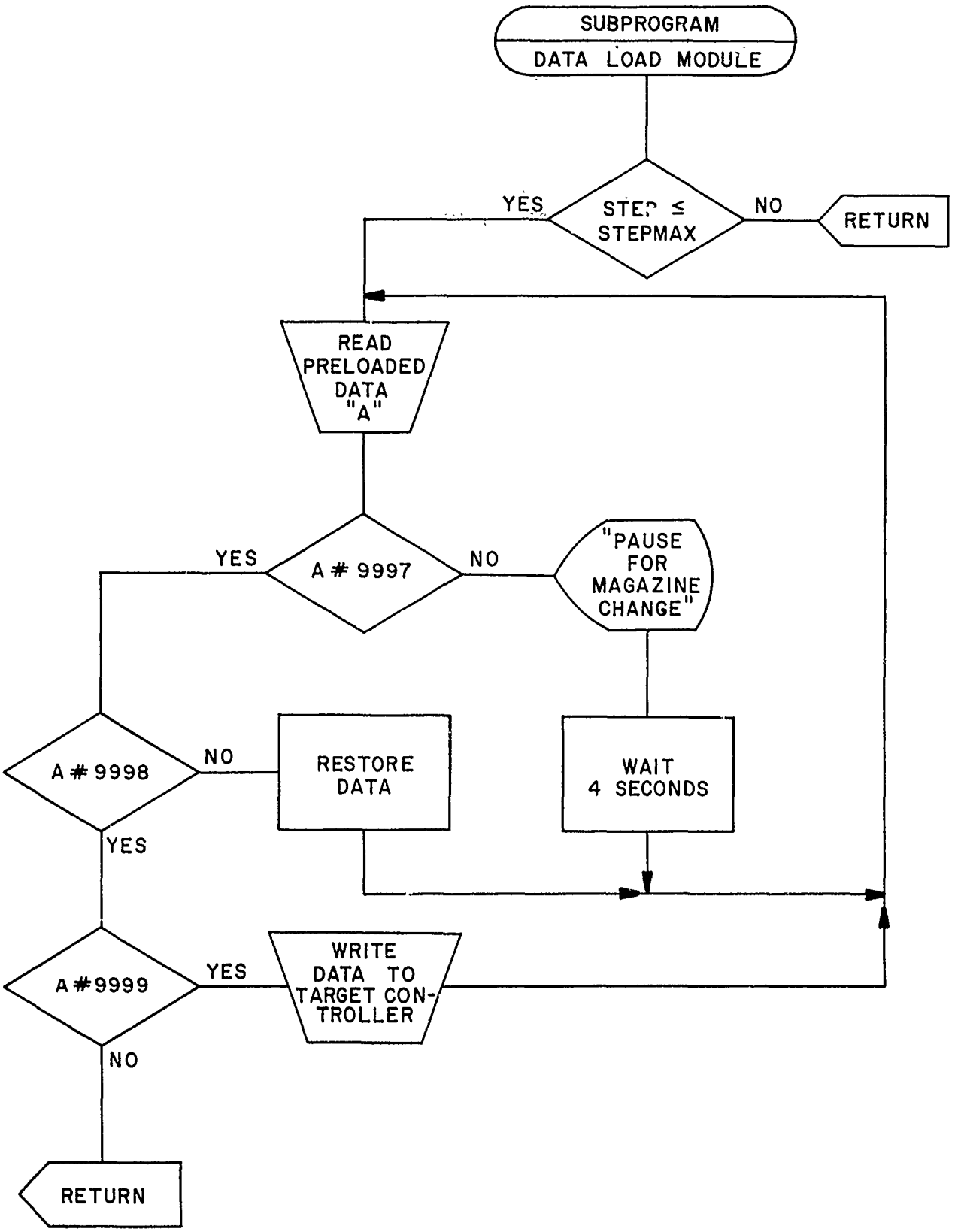
FUNCTION	H-P CODE (DECIMAL)
ERASE	216
START	217
MANUAL	218
KILL YES	226
KILL NO	225
MOVING TARGET CARTS	
M-1	115
M-2	113
M-3	179
M-4	177
M-5	243
M-6	241
TARGET PRESENTATION TIMES	
T-1	219
T-2	220
T-3	221
T-4	222
COMPUTER GENERATED TIME	223
LOAD PRESTART TIME	61
LOAD TARGET UP TIME	62
LOAD STOP DELAY TIME	63
TIME INTERVAL COUNTER	
RUN	114
STANDBY	112

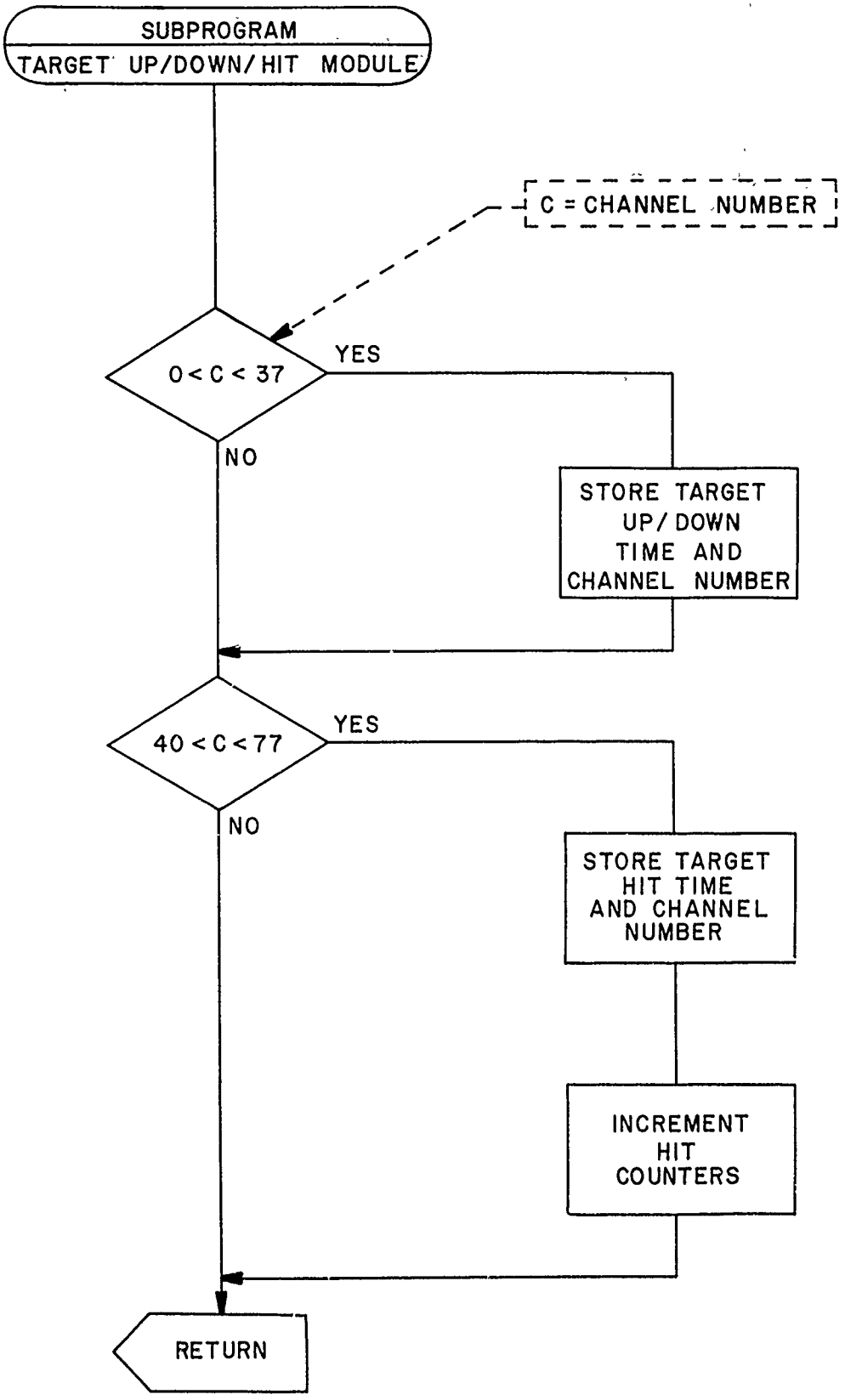
APPENDIX C

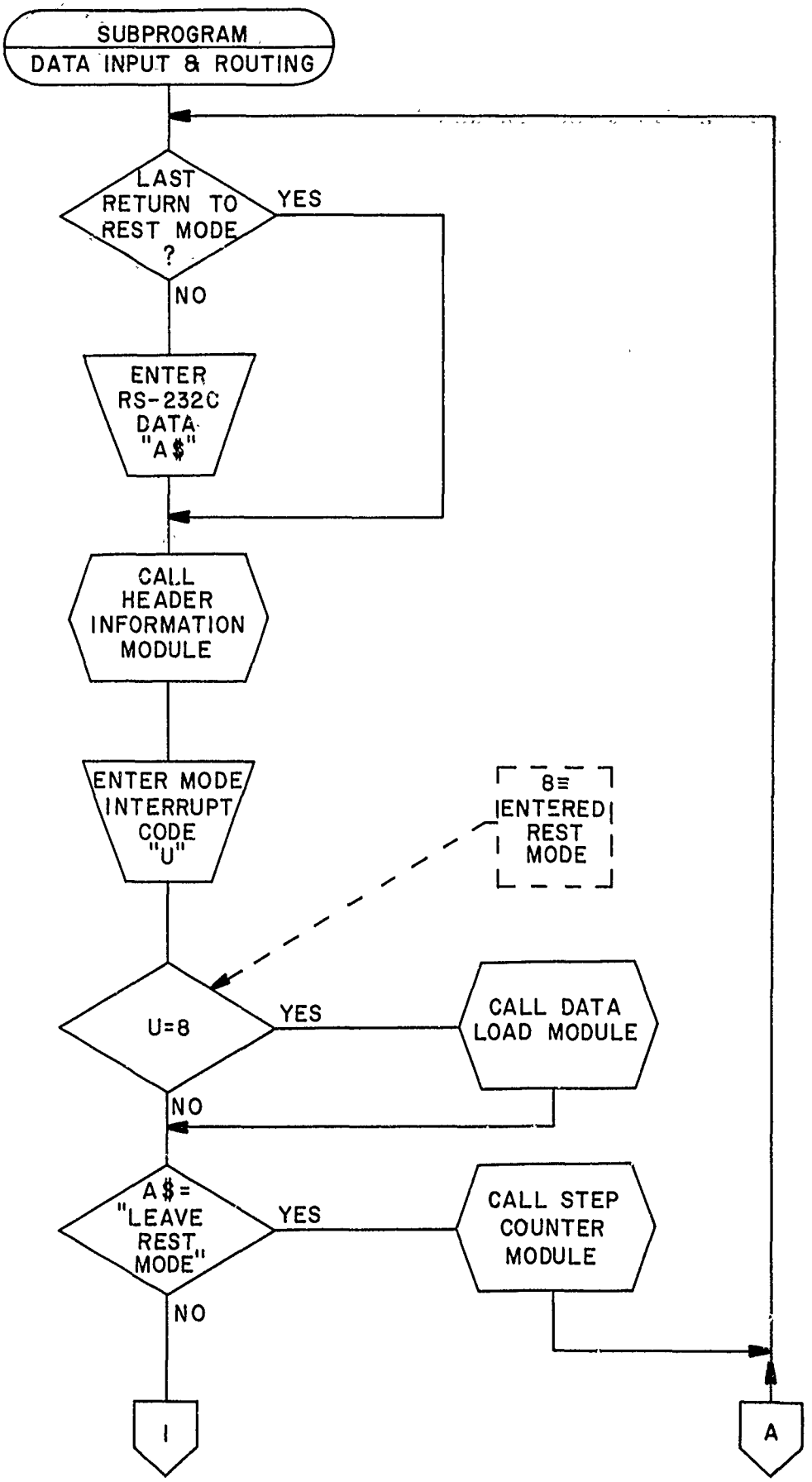
TYPICAL BASIC PROGRAM FLOWCHART

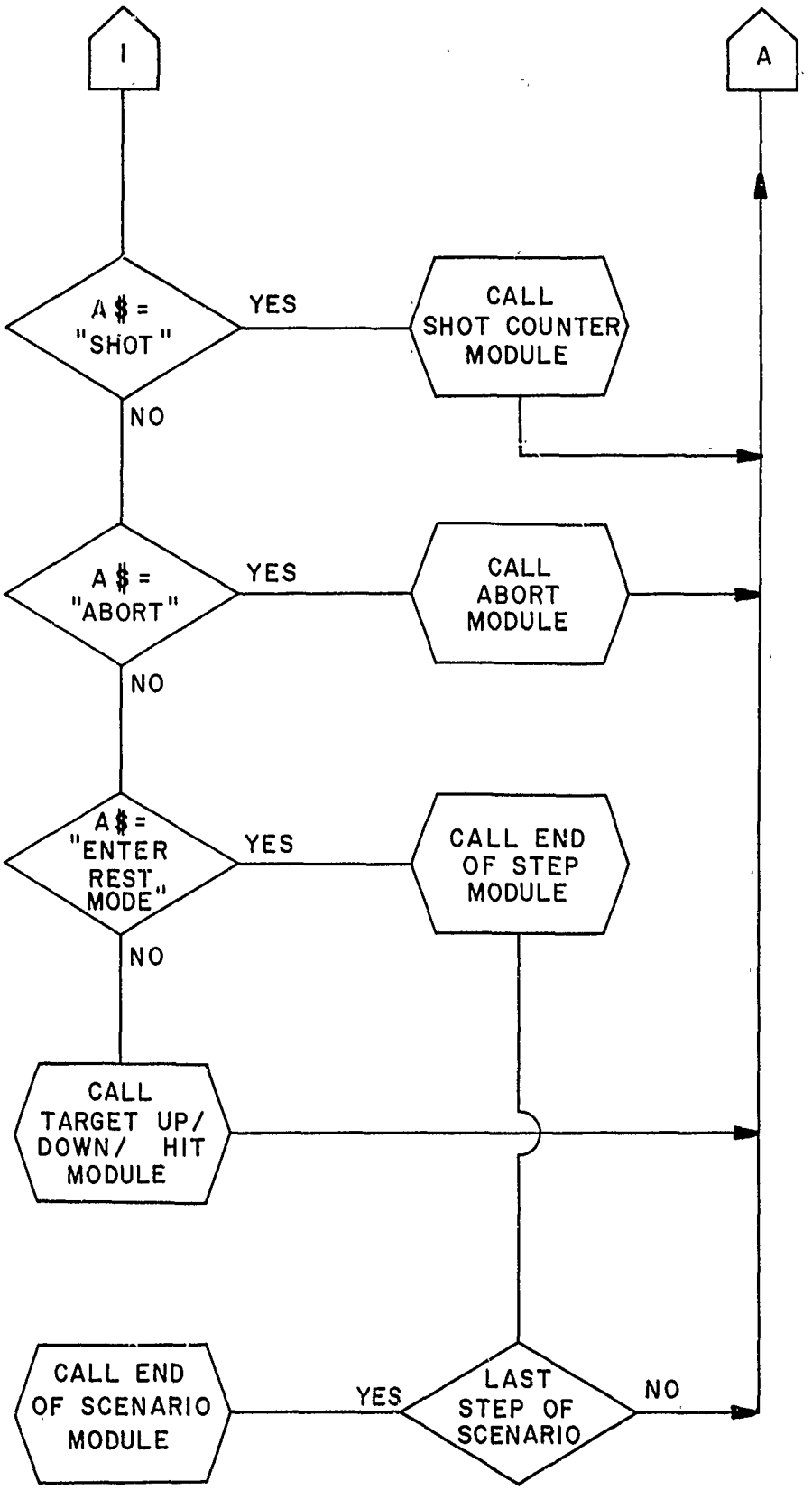

BEGIN
INITIALIZE STEP, SHOT, HIT COUNTERS
INITIALIZE TARGET CONTROLLER FUNCTIONS
CALL DATA COLLECTION MODULE

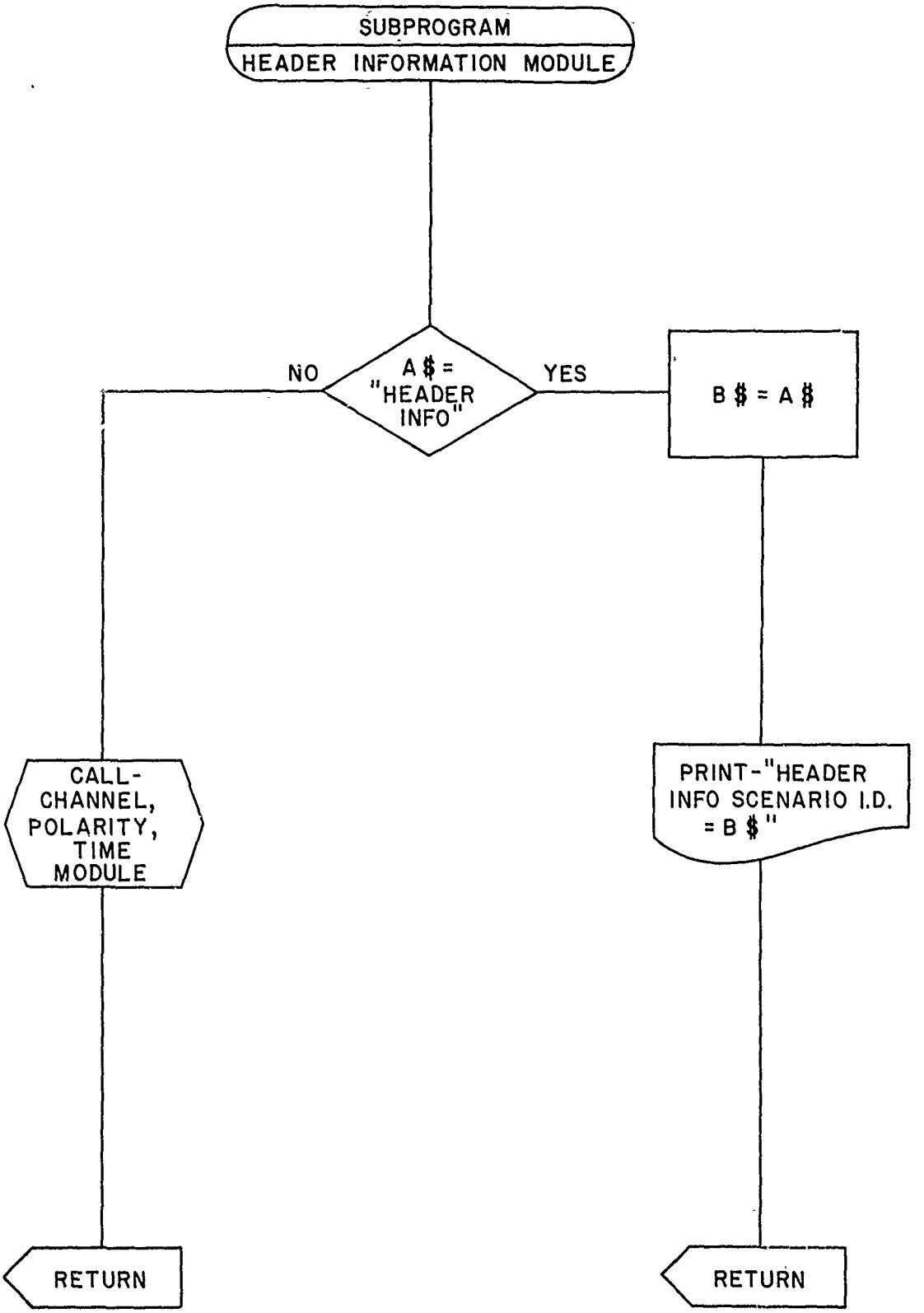

SUBPROGRAM
DATA COLLECTION MODULE
INITIALIZE PROGRAM VARIABLES
CALL DATA LOAD MODULE
CALL DATA INPUT & ROUTING MODULE

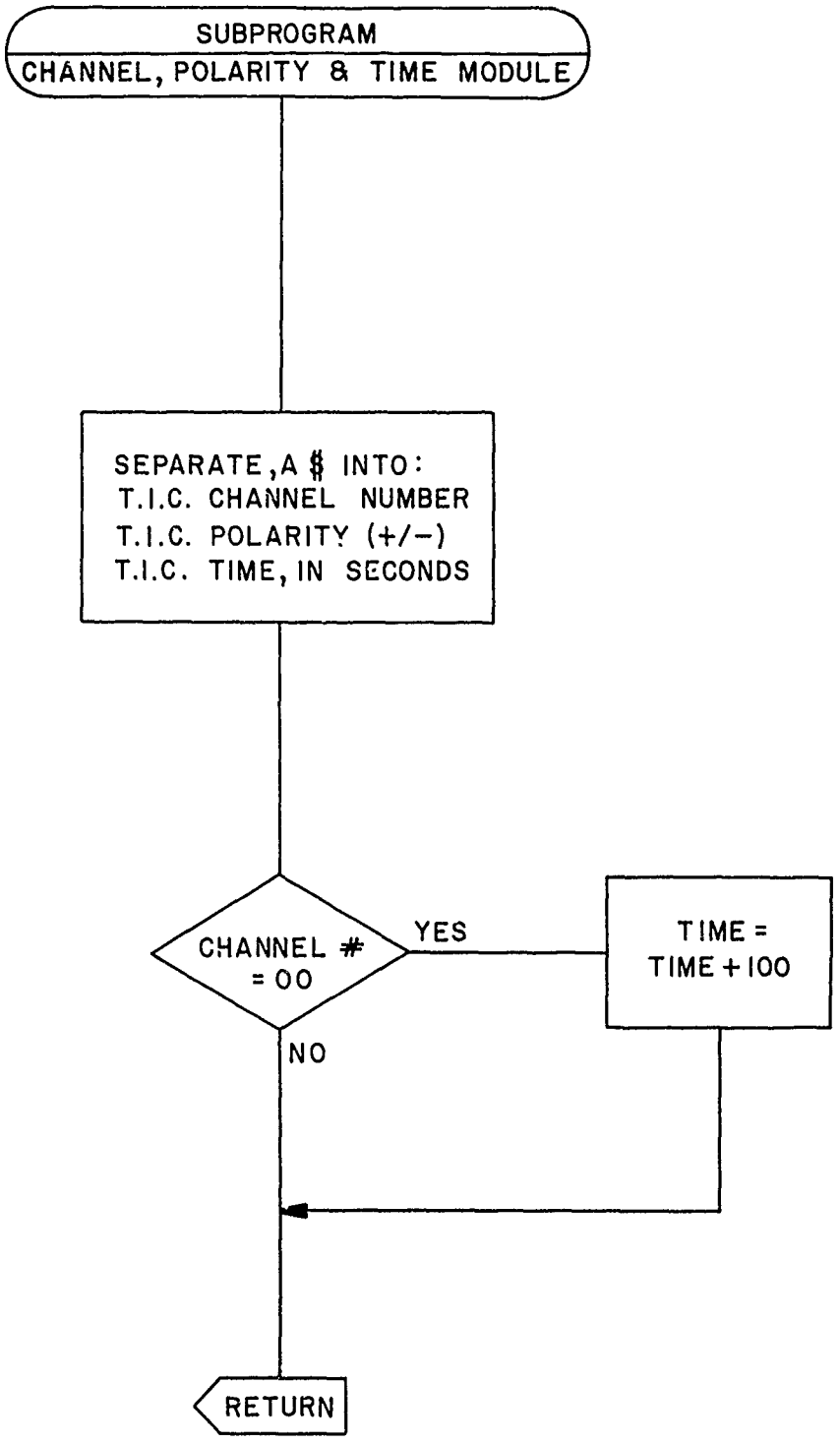

SUBPROGRAM
DATA LOAD MODULE
STEP ≤ STEPMAX
YES
NO
RETURN
READ PRELOADED DATA "A"
A # 9997
YES
NO
"PAUSE FOR MAGAZINE CHANGE"
A # 9998
NO
RESTORE DATA
WAIT 4 SECONDS
YES
A # 9999
YES
WRITE DATA TO TARGET CONTROLLER
NO
RETURN

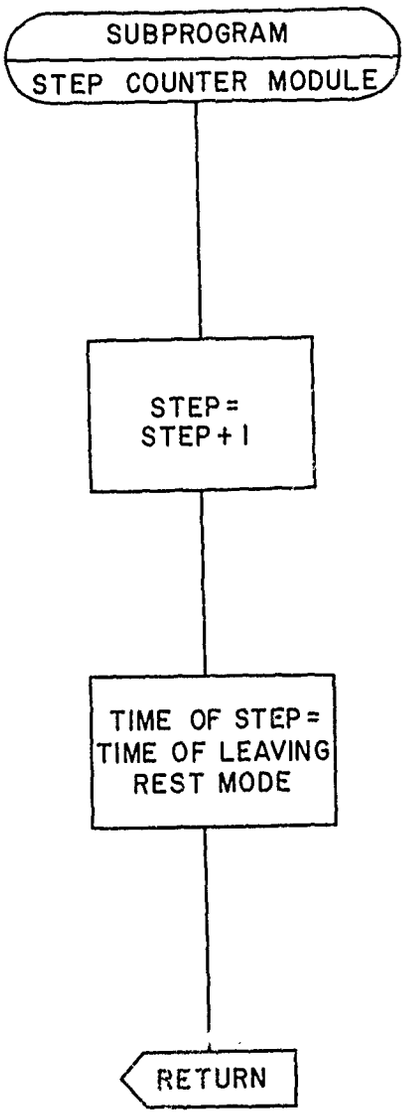

SUBPROGRAM
TARGET UP/DOWN/HIT MODULE
C = CHANNEL NUMBER
0 < C < 37
YES
NO
STORE TARGET UP/DOWN TIME AND CHANNEL NUMBER
40 < C < 77
YES
NO
STORE TARGET HIT TIME AND CHANNEL NUMBER
INCREMENT HIT COUNTERS
RETURN

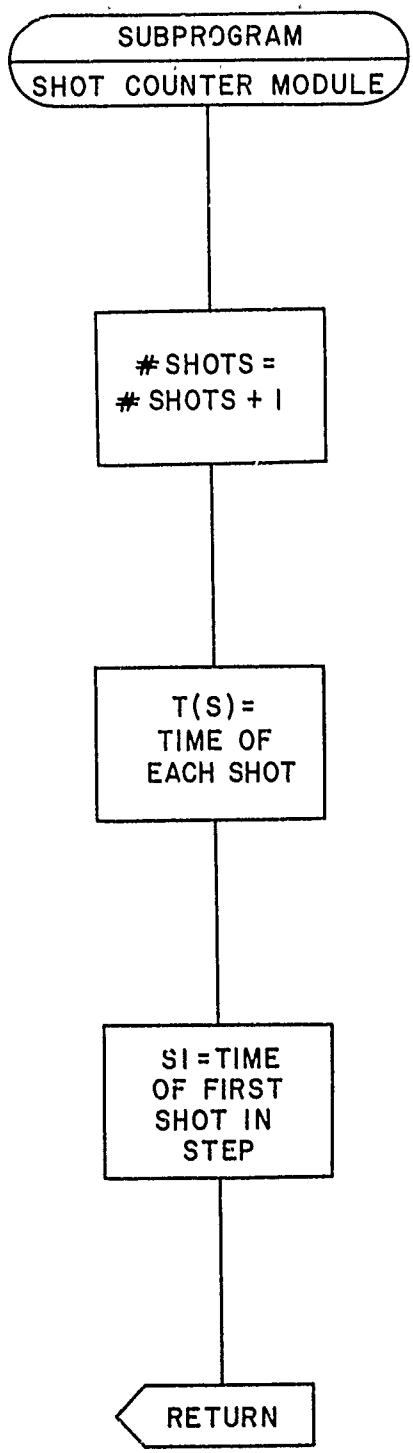

SUBPROGRAM
DATA INPUT & ROUTING
LAST RETURN TO REST MODE ?
YES
NO
ENTER RS-232C DATA "A$"
CALL HEADER INFORMATION MODULE
ENTER MODE INTERRUPT CODE "U"
8≡ ENTERED REST MODE
U=8
YES
CALL DATA LOAD MODULE
NO
A$= "LEAVE REST MODE"
YES
CALL STEP COUNTER MODULE
NO
I
A

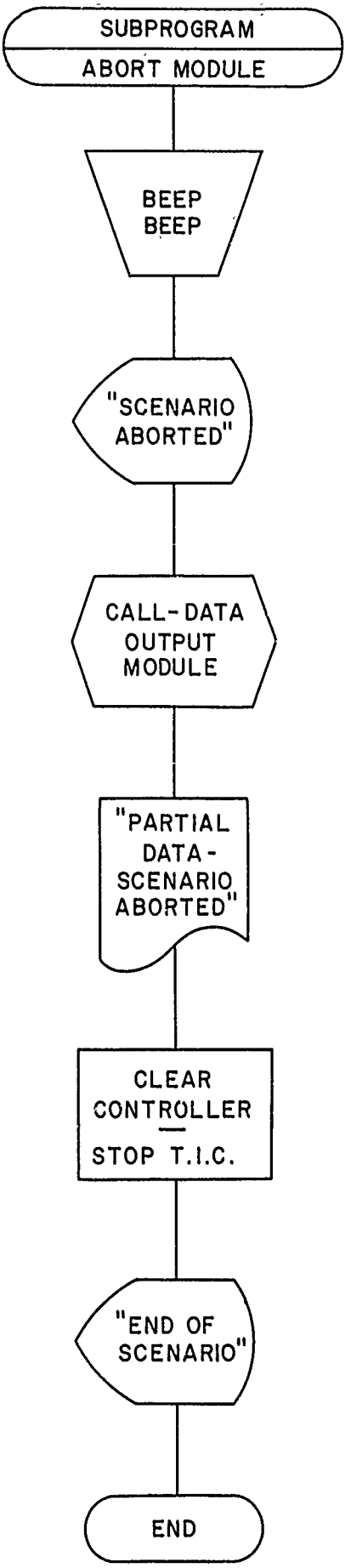

I
A
A$ = "SHOT"
YES
CALL SHOT COUNTER MODULE
NO
A$ = "ABORT"
YES
CALL ABORT MODULE
NO
A$ = "ENTER REST MODE"
YES
CALL END OF STEP MODULE
NO
CALL TARGET UP/ DOWN/ HIT MODULE
CALL END OF SCENARIO MODULE
YES
LAST STEP OF SCENARIO
NO

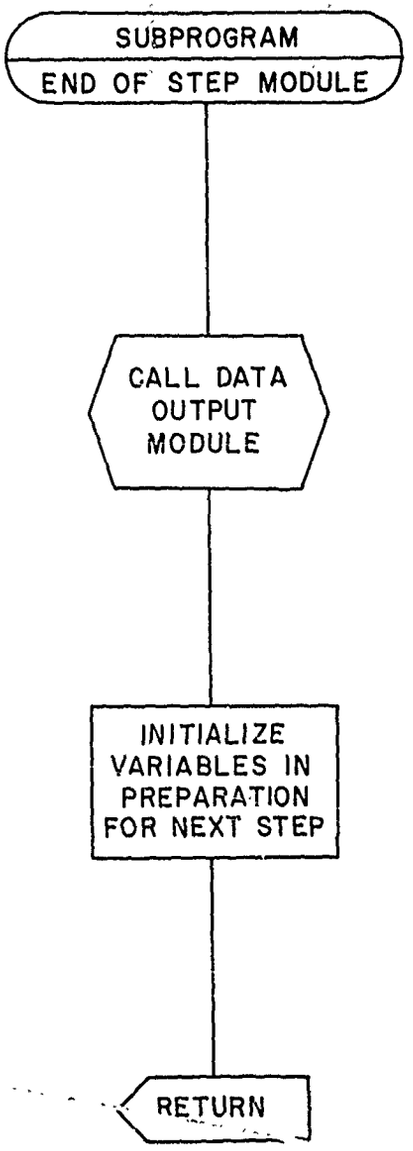

SUBPROGRAM
HEADER INFORMATION MODULE
A$ = "HEADER INFO"
NO
YES
B$ = A$
CALL-CHANNEL, POLARITY, TIME MODULE
PRINT-"HEADER INFO SCENARIO I.D. = B$"
RETURN
RETURN

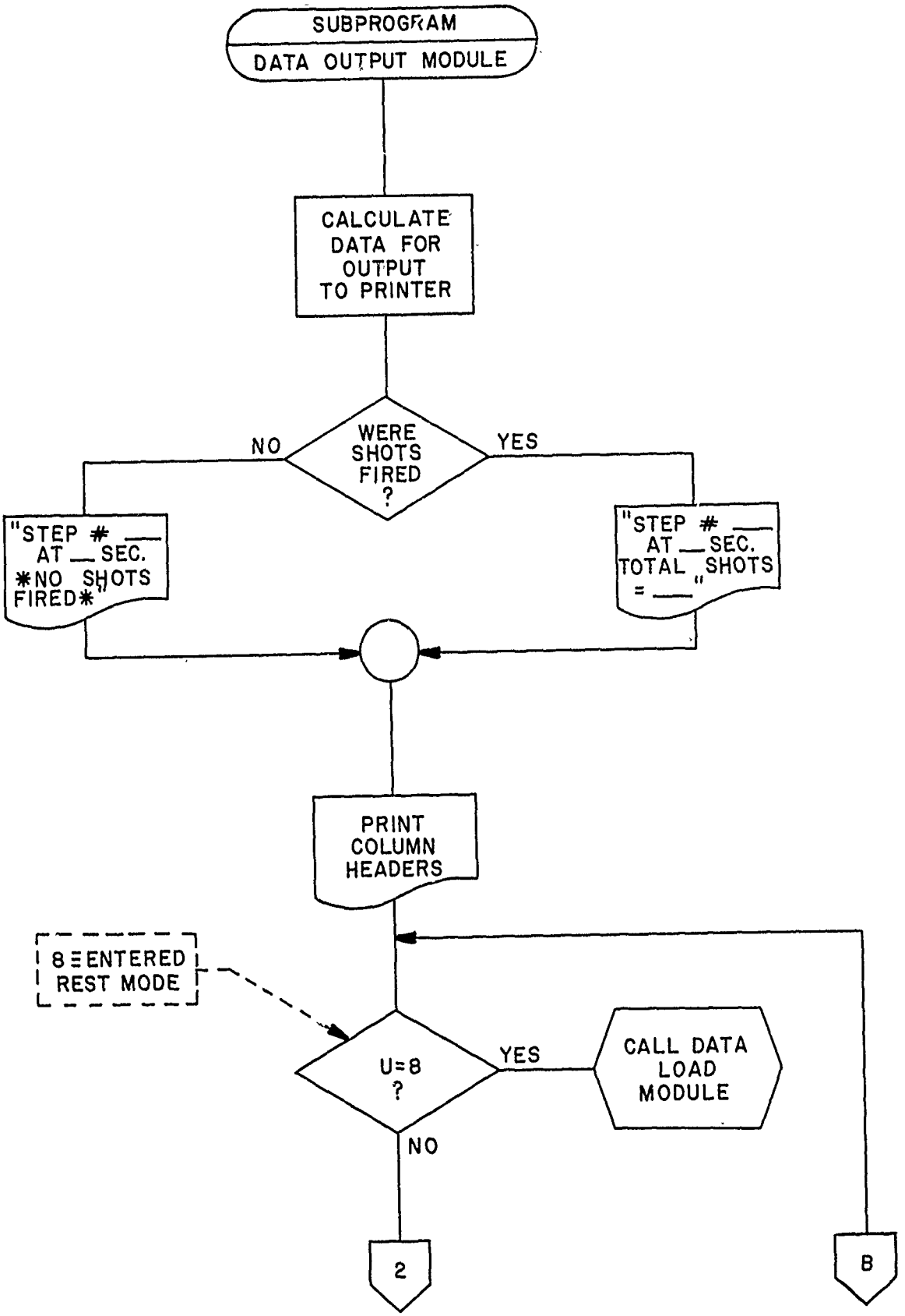

SUBPROGRAM
CHANNEL, POLARITY & TIME MODULE
SEPARATE, A $ INTO:
T.I.C. CHANNEL NUMBER
T.I.C. POLARITY (+/-)
T.I.C. TIME, IN SECONDS
CHANNEL # = 00
YES
TIME = TIME + 100
NO
RETURN

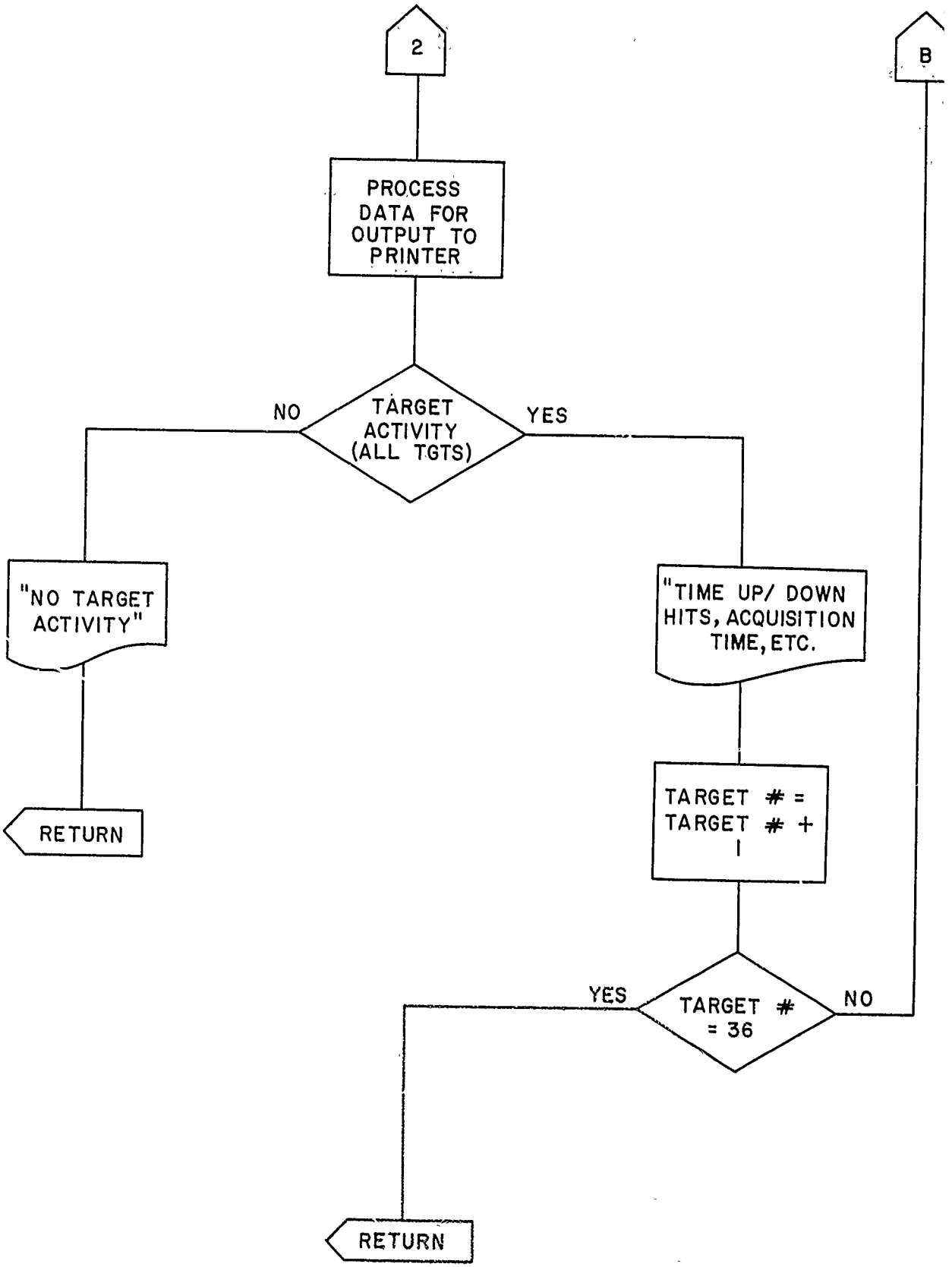

SUBPROGRAM
STEP COUNTER MODULE
STEP=
STEP+1
TIME OF STEP=
TIME OF LEAVING
REST MODE
RETURN

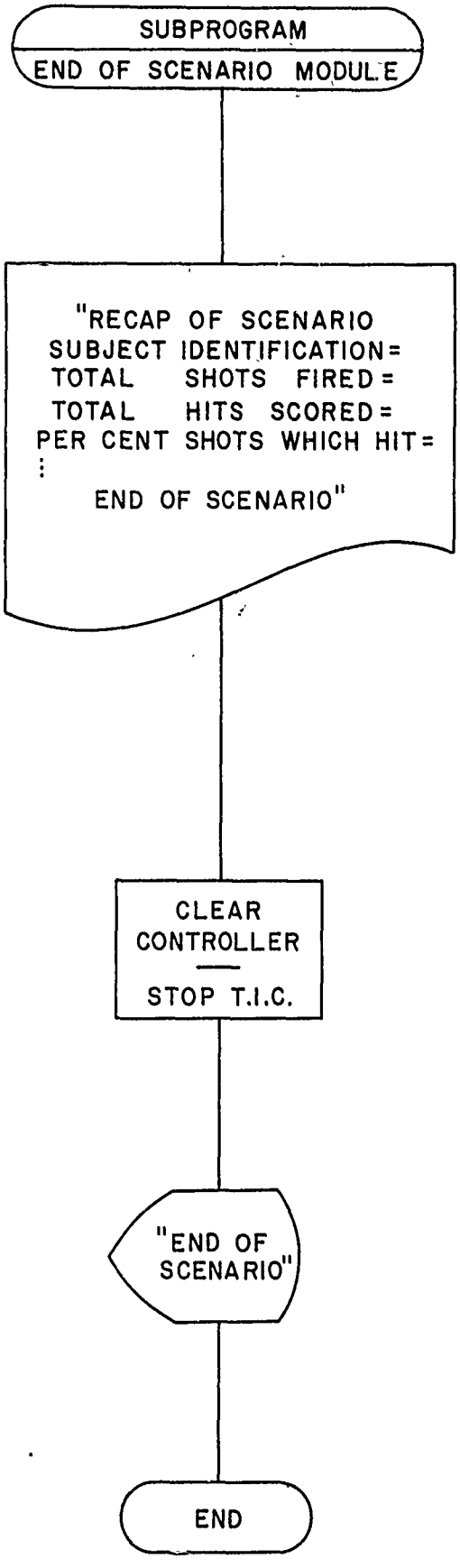

SUBPROGRAM
SHOT COUNTER MODULE
SHOTS =
SHOTS + 1
T(S) =
TIME OF
EACH SHOT
SI = TIME
OF FIRST
SHOT IN
STEP
RETURN


SUBPROGRAM
ABORT MODULE
BEEP
BEEP
"SCENARIO ABORTED"
CALL-DATA OUTPUT MODULE
"PARTIAL DATA-SCENARIO ABORTED"
CLEAR CONTROLLER
STOP T.I.C.
"END OF SCENARIO"
END


SUBPROGRAM
END OF STEP MODULE
CALL DATA OUTPUT MODULE
INITIALIZE VARIABLES IN PREPARATION FOR NEXT STEP
RETURN


SUBPROGRAM
DATA OUTPUT MODULE
CALCULATE DATA FOR OUTPUT TO PRINTER
WERE SHOTS FIRED ?
NO
YES
"STEP # ___ AT __ SEC. *NO SHOTS FIRED*"
"STEP # ___ AT __ SEC. TOTAL "SHOTS = ___"
PRINT COLUMN HEADERS
8 = ENTERED REST MODE
U=8 ?
YES
CALL DATA LOAD MODULE
NO
2
B


2
B
PROCESS DATA FOR OUTPUT TO PRINTER
TARGET ACTIVITY (ALL TGTS)
NO
YES
"NO TARGET ACTIVITY"
RETURN
"TIME UP/ DOWN HITS, ACQUISITION TIME, ETC.
TARGET # = TARGET # + 1
TARGET # = 36
YES
NO
RETURN


SUBPROGRAM
END OF SCENARIO MODULE
"RECAP OF SCENARIO
SUBJECT IDENTIFICATION=
TOTAL SHOTS FIRED=
TOTAL HITS SCORED=
PER CENT SHOTS WHICH HIT=
⋮
END OF SCENARIO"
CLEAR CONTROLLER
STOP T.I.C.
"END OF SCENARIO"
END

APPENDIX D

TYPICAL BASIC PROGRAM LISTING

```
5 REM STORED 15-JUN-81 AT 2032, BEA
10 REM          1 0   M E T E R /  S T A N D I N G   S C E N A R I O
20 REM ////////////////////////////////////////////////////////////////////////
30 REM   THIS SAMPLE PROGRAM USES DATA AVAILABLE IN DATA STATEMENTS
40 REM   TO GENERATE A TARGET PRESENTATION SCENARIO
50 REM   TARGETS 17, 18, 19 PRESENTED INDIVIDUALLY, THEN 17, 18, 19 ARRAY--
60 REM   REPEATED 5 TIMES FOR A TOTAL OF 20 STEPS IN SCENARIO.
70 REM   LOAD TARGET CONTROLLER TIMES:
80 REM           PRESTART   = 0.1 SEC
90 REM           T-1        = 2.0 SEC
100 REM          T-2        = 5.0 SEC
110 REM          STOP DELAY = 6.0 SEC
120 REM     CREATED  13-JUN-81,  B.E. AMREIN
130 REM     STORE IN FILE 0 (M-RANGE TAPE #3); (FILE 0,BACKUP #3)
140 REM////////////////////////////////////////////////////////////////////////
150 REM
160 REM   INITIALIZE STEP, SHOT AND HIT COUNTERS
170 N9=0
180 S9=0
190 H9=0
200 REM INITIALIZE NUMBER OF STEPS IN SCENARIO
210 X=20
220 REM INITIALIZE TARGET CONTROLLER FUNCTIONS
230 REM TARGETS GO DOWN WHEN HIT (DWH)
240 WRITE (2,300)226;
250 REM START TIME-INTERVAL-COUNTER (T.I.C.)
260 WRITE (2,300)114;
270 REM   GO TO SUBPROGRAM TO START SEQUENCE
280 GOTO 490
290 REM   DATA LOAD SEQUENCE
300 FORMAT B
310 N9=N9+1
320 IF N9#(X+1) THEN 370
330 RETURN
340 END
350 DATA 216,219,211,211,217,9999,216,210,210,217,9999,216,209,209,217,9999
360 DATA 9997,216,220,211,211,210,209,217,9999,9997,9998
370 READ A
380 IF A#9997 THEN 420
390 DISP "PAUSE FOR MAGAZINE CHANGE"
400 WAIT 4000
410 GOTO 370
420 IF A#9998 THEN 450
430 RESTORE
440 GOTO 370
450 IF A=9999 THEN 480
460 WRITE (2,300)A;
470 GOTO 370
480 RETURN
490 REM ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
500 REM  S U B P R O G R A M
510 REM   THIS SUBPROGRAM COLLECTS & HANDLES ALL DATA IN ASCII FORM
520 REM   FROM THE QUAD RC-100 T.I.C.
530 REM   CREATED BY B.E. AMREIN;   25-SEP-80
540 REM ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
550 REM
560 REM
570 REM **************************************************************************
580 REM   L I S T   O F   V A R I A B L E S
590 REM
600 REM    A       = TIME TO ACQUIRE TARGET & FIRE FIRST ROUND
610 REM    A$      = RAW DATA FROM T.I.C.
620 REM    B$      = HEADER INFO
630 REM    C       = T.I.C. CHANNEL NUMBER (60 THRU 80)
640 REM    C1      = TARGET NUMBER (ALWAYS LESS THEN 37)
```

```
650 REM     D(C,1)   = TARGET DOWN TIME
660 REM     D(C,2)   = TARGET UP TIME
670 REM     D(C1,3) = TIME OF FIRST HIT
680 REM     D(C1,4) = NUMBER OF HITS PER TARGET PER STEP
690 REM     E1       = TARGET DOWN TIME REFERENCED TO T0
700 REM     E2       = TARGET UP TIME REFERENCED TO T0
710 REM     E3       = TIME OF FIRST HIT REFERENCED TO T0
720 REM     F        = TARGET EXPOSURE TIME
730 REM     G(S)     = TARGET # HIT BY SHOT "S"
740 REM     H        = POLARITY (1="-", 2="+")
750 REM     H9       = NUMBER OF HITS SCORED IN SCENARIO
760 REM     I        = TEMPORARY INDEX
770 REM     I1       = TEMPORARY STORAGE (OUTPUT MODULE)
780 REM     J        = TEMPORARY INDEX
790 REM     M        = STEP NUMBER IN SCENARIO
800 REM     N        = NUMBER OF CLOCK CYCLES ON T.I.C. (100 SEC/CYCLE)
810 REM     N9       = COUNTS STEPS IN SCENARIO
820 REM     P        = PRINT COUNTER (COUNTS OUTPUT LINES IN OUTPUT MODULE)
830 REM     Q        = TIME OF A HIT IN STEP REFERENCED TO T0
840 REM     R        = TIME OF A SHOT IN STEP REFERENCED TO T0
850 REM     S        = NUMBER OF SHOTS FIRED IN A SCENARIO STEP
860 REM     S1       = TIME OF FIRST SHOT IN A STEP
870 REM     S9       = TOTAL NUMBER OF SHOTS FIRED IN SCENARIO
880 REM     T        = TIME, CORRECTED, CUMULATIVE, IN SECONDS
890 REM     T0       = TIME-ZERO: FIRST TARGET-UP TIME IN A STEP (=0.0 SEC.)
900 REM     T1       = TIME OF LEAVING REST MODE
910 REM     T9       = INTERSTEP TIME (BEGINNING TO BEGINNING)
920 REM     U        = MODE INTERRUPT (4=STOP DELAY, 8=REST)
930 REM     V(M)     = TEMPORARY STORAGE TO COMPUTE T9
940 REM     W(S)     = TIME OF EACH SHOT IN STEP
950 REM     X        = NUMBER OF STEPS DESIRED IN A SCENARIO
960 REM     Y(S)     = TIME OF EACH HIT IN STEP
970 REM     Z        = CHECK FOR TARGET ACTIVITY
980 REM     Z1       = CHECK FOR NO TARGET ACTIVITY
990 REM
1000 REM ************************************************************************
1010 REM
1020 REM
1030 REM ************************************************************************
1040 REM   I N I T I A L I Z A T I O N    M O D U L E
1050 DIM A$[20],B$[20],G[100]
1060 DIM D[37,4],V[35]
1070 DIM W[100],Y[100]
1080 MAT D=ZER
1090 MAT W=ZER
1100 MAT Y=ZER
1110 MAT G=ZER
1120 C=9999
1130 H=0
1140 I1=0
1150 N=0
1160 S=0
1170 S1=0
1180 M=0
1190 Z1=0
1200 REM ************************************************************************
1210 REM *****LOAD CONTROLLER WITH INSTRUCTIONS***"
1220 GOSUB 300
1230 REM
1240 REM ************************************************************************
1250 REM  S U B P R O G R A M
1260 REM   D A T A   I N P U T   &   R O U T I N G    M O D U L E
1270 REM DETECT RETURN TO REST MODE OF LAST STEP OF SCENARIO
1280 IF M#X THEN 1330
1290 IF C#40 THEN 1330
```

```
1300 IF H=2 THEN 1340
1310 REM INPUT 7 IS RS-232C FROM T.I.C.
1320 REM BAUD RATE IS 1200;  CTS IS ACTIVATED BY HP-9830
1330 ENTER (7,*)A$
1340 GOSUB 1650
1350 REM INTERRUPT RS-232C DATA INPUT TO LOAD NEXT STEP
1360 IF N9 >= X THEN 1400
1370 U=RBYTE2
1380 IF U#8 THEN 1400
1390 GOSUB 300
1400 U=0
1410 IF C=9999 THEN 1280
1420 IF C#40 THEN 1460
1430 IF H#1 THEN 1460
1440 GOSUB 3390
1450 GOTO 1280
1460 IF C#80 THEN 1490
1470 GOSUB 3230
1480 GOTO 1280
1490 IF C#79 THEN 1520
1500 GOSUB 3500
1510 GOTO 1280
1520 IF C#40 THEN 1580
1530 IF H#2 THEN 1580
1540 GOSUB 3720
1550 REM CHECK FOR STEP NUMBER EQUAL TO NUMBER OF STEPS IN SCENARIO
1560 IF M >= X THEN 1600
1570 GOTO 1280
1580 GOSUB 2090
1590 GOTO 1280
1600 GOSUB 3870
1610 REM ************************************************************************
1620 REM
1630 REM
1640 REM ************************************************************************
1650 REM  S U B P R O G R A M
1660 REM  H E A D E R   I N F O R M A T I O N   M O D U L E
1670 REM   DETECTS, PRINTS & STORES HEADER INFO IN B$
1680 IF A$[1,1]="A" THEN 1800
1690 IF A$[1,1]="B" THEN 1800
1700 IF A$[1,1]="C" THEN 1800
1710 IF A$[1,1]="D" THEN 1800
1720 IF A$[1,1]="E" THEN 1800
1730 IF A$[1,1]="F" THEN 1800
1740 IF A$[1,1]="G" THEN 1800
1750 IF A$[1,1]="H" THEN 1800
1760 IF A$[1,1]="I" THEN 1800
1770 IF A$[1,1]="J" THEN 1800
1780 GOSUB 1900
1790 RETURN
1800 B$=A$
1810 PRINT "      1 0   M E T E R / S T A N D I N G   S C E N A R I O"
1820 PRINT "************************************************************"
1830 PRINT "H E A D E R   I N F O :    S C E N A R I O  I. D. =   "B$
1840 PRINT
1850 RETURN
1860 REM ************************************************************************
1870 REM
1880 REM
1890 REM ************************************************************************
1900 REM   S U B P R O G R A M
1910 REM   C H A N N E L,  P O L A R I T Y  &   T I M E    M O D U L E
1920 REM  C = T.I.C. CHANNEL NUMBER (00 THRU 80)
1930 REM  H = POLARITY (2= "+",  1= "-")
1940 REM  T = CORRECTED TIME, CUMULATIVE, IN SECONDS
```

```
1950 C=VAL(A$[1,2])
1960 IF A$[4,4]="-" THEN 1990
1970 H=2
1980 GOTO 2010
1990 H=1
2000 REM COMPENSATE FOR 100 SECOND REPEAT INTERVAL ON T.I.C.
2010 IF C#0 THEN 2030
2020 N=N+1
2030 T=100*N+VAL(A$[5,8])/100
2040 RETURN
2050 REM ************************************************************************
2060 REM
2070 REM
2080 REM ************************************************************************
2090 REM   S U B P R O G R A M
2100 REM  T A R G E T  U P / D O W N / H I T   M O D U L E
2110 IF C>0 THEN 2130
2120 GOTO 2140
2130 IF C<37 THEN 2150
2140 GOTO 2160
2150 D[C,H]=T
2160 IF C>40 THEN 2180
2170 GOTO 2190
2180 IF C<77 THEN 2200
2190 GOTO 2300
2200 C1=C-40
2210 H9=H9+1
2220 D[C1,4]=D[C1,4]+1
2230 IF D[C1,3]#0 THEN 2300
2240 D[C1,3]=T
2250 REM Y(S)= TIME OF EACH HIT IN STEP;  G(S)=TARGET # HIT
2260 IF S#0 THEN 2280
2270 S=1
2280 Y[S]=T
2290 G[S]=C1
2300 RETURN
2310 REM ************************************************************************
2320 REM
2330 REM
2340 REM ************************************************************************
2350 REM   S U B P R O G R A M
2360 REM   D A T A   O U T P U T   M O D U L E
2370 REM   PRINTS DATA OUT TO PRINTER AFTER EVERY STEP
2380 V[M]=T1
2390 IF M#1 THEN 2420
2400 M1=1
2410 GOTO 2430
2420 M1=M-1
2430 T9=V[M]-V[M1]
2440 REM CALCULATE T0 (FIRST TARGET-UP TIME IN A STEP)
2450 T0=9999
2460 FOR I=1 TO 36
2470 IF D[I,2]=0 THEN 2500
2480 IF D[I,2]>T0 THEN 2500
2490 T0=D[I,2]
2500 NEXT I
2510 IF S#0 THEN 2540
2520 PRINT "STEP # "M"AT "T1"SEC   *** N O   S H O T S   F I R E D ***"
2530 GOTO 2690
2540 PRINT "STEP # "M"AT "T1"SEC        TOTAL SHOTS FIRED= "S
2550 PRINT
2560 FORMAT 5X,"SHOT # ",F3.0," AT ",F5.2," SEC",4X
2570 FORMAT "HIT AT ",F5.2," SEC",5X,"TARGET # ",F3.0
2580 FORMAT "***NO HIT DETECTED***"
2590 FOR I=1 TO S
2600 REM REFERENCE EACH SHOT & HIT TIME TO T0
2610 R=W[I]-T0
```

```
2620 Q=Y[I]-T0
2630 WRITE (15,2560)I,R;
2640 IF G[I]=0 THEN 2670
2650 WRITE (15,2570)Q,G[I]
2660 GOTO 2680
2670 WRITE (15,2580)
2680 NEXT I
2690 PRINT
2700 PRINT TAB10"TARGET"TAB20"TGT UP"TAB30"TGT EXP"TAB40"1ST HIT";
2710 PRINT TAB50"NUMBER"TAB60"ACQUISITION"
2720 PRINT TAB10"NUMBER"TAB21"TIME"TAB31"TIME"TAB41"TIME"TAB50"OF HITS";
2730 PRINT TAB63"TIME"
2740 FORMAT 11X,F3.0,5X,F6.2,4X,F6.2,4X,F6.2,4X,F6.0,6X,F6.2
2750 P=0
2760 FOR I=1 TO 36
2770 REM INTERRUPT DATA OUTPUT TO LOAD NEXT STEP OF SCENARIO
2780 IF N9 >= X THEN 2820
2790 U=RBYTE2
2800 IF U#8 THEN 2820
2810 GOSUB 300
2820 U=0
2830 Z=D[I,1]+D[I,2]+D[I,3]+D[I,4]
2840 IF Z=0 THEN 3120
2850 P=P+1
2860 Z1=Z1+Z
2870 REM REFERENCE ALL UP/DOWN/HIT TIMES TO T0
2880 E1=D[I,1]-T0
2890 E2=D[I,2]-T0
2900 E3=D[I,3]-T0
2910 IF E3>0 THEN 2930
2920 E3=0
2930 REM CALCULATE TARGET EXPOSURE TIME
2940 F=E1-E2
2950 REM CALCULATE TARGET ACQUISITION TIME
2960 REM  A S S U M P T I O N: SUBJECTS ARE INSTRUCTED TO ACQUIRE TARGETS
2970 REM                       IN ASCENDING NUMBERICAL ORDER
2980 IF P>1 THEN 3030
2990 A=S1-T0
3000 IF A>0 THEN 3020
3010 A=0
3020 GOTO 3100
3030 FOR J=1 TO S
3040 IF W[J]<(D[I1,1]+0.075) THEN 3070
3050 A=W[J]-D[I1,1]
3060 GOTO 3100
3070 IF A>0 THEN 3090
3080 A=0
3090 NEXT J
3100 WRITE (15,2740)I,E2,F,E3,D[I,4],A
3110 I1=I
3120 NEXT I
3130 IF Z1#0 THEN 3150
3140 PRINT TAB10"******** N O   T A R G E T   A C T I V I T Y  ********"
3150 PRINT
3160 PRINT
3170 PRINT
3180 RETURN
3190 REM ***************************************************************
3200 REM
3210 REM
3220 REM ***************************************************************
3230 REM   S U B P R O G R A M
3240 REM   S H O T   C O U N T E R  &   T I M I N G   M O D U L E
3250 REM COUNTS SHOTS & ASSIGNS TIME TO ALL SHOTS
3260 REM  S = NUMBER OF SHOTS FIRED IN A STEP OF SCENARIO
3270 REM  S1= TIME OF FIRST SHOT IN STEP
```

```
3280 REM  W(S)= TIME OF EACH SHOT IN STEP
3290 S=S+1
3300 S9=S9+1
3310 W[S]=T
3320 IF S#1 THEN 3340
3330 S1=T
3340 RETURN
3350 REM ******************************************************************
3360 REM
3370 REM
3380 REM *****************************************************************
3390 REM   S U B P R O G R A M
3400 REM   S T E P   C 0 U N T E R   M O D U L E
3410 REM   STARTS DATA COLLECTION SEQUENCE
3420 REM   M = STEP NUMBER OF SCENARIO
3430 M=M+1
3440 T1=T
3450 RETURN
3460 REM ****************************************************************
3470 REM
3480 REM
3490 REM ****************************************************************
3500 REM   S U B P R O G R A M
3510 REM   A B O R T   M O D U L E
3520 REM HANDLES ABORT COMMAND FROM PUSHBUTTON
3530 BEEP
3540 WAIT 1000
3550 BEEP
3560 DISP "S C E N A R I O   A B O R T E D"
3570 WAIT 2000
3580 GOSUB 2350
3590 PRINT TAB10"**********************************************************"
3600 PRINT TAB10"**********PARTIAL DATA;   SCENARIO ABORTED**********"
3610 PRINT TAB10"**********************************************************"
3620 PRINT
3630 PRINT
3640 GOSUB 4120
3650 PRINT
3660 STOP
3670 RETURN
3680 REM ****************************************************************
3690 REM
3700 REM
3710 REM *****************************************************************
3720 REM   S U B P R O G R A M
3730 REM   E N D   O F   S T E P   M O D U L E
3740 REM HANDLES ENTRANCE INTO REST MODE
3750 GOSUB 2350
3760 REM CLEAR DATA & PREPARE FOR NEXT STEP OF SCENARIO
3770 MAT D=ZER
3780 MAT W=ZER
3790 MAT Y=ZER
3800 MAT G=ZER
3810 S=0
3820 Z1=0
3830 RETURN
3840 REM *****************************************************************
3850 REM
3860 REM
3870 REM ****************************************************************
3880 REM  S U B P R O G R A M
3890 REM  E N D   O F   S C E N A R I O   M O D U L E
3900 PRINT
3910 PRINT
3920 PRINT "+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++"
```

```
3930 PRINT "     R E C A P   O F   S C E N A R I O"
3940 PRINT
3950 PRINT "S U B J E C T   I D E N T I F I C A T I O N =  "B$
3960 PRINT
3970 PRINT "T O T A L   #   S H O T S   F I R E D = "S9
3980 PRINT
3990 PRINT "T O T A L   #   O F   H I T S   S C O R E D =  "H9
4000 PRINT
4010 IF S9=0 THEN 4030
4020 PRINT "P E R   C E N T   S H O T S   W H I C H   H I T = "(H9*100)/S9
4030 PRINT
4040 PRINT "++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++"
4050 FOR I=1 TO 20
4060 PRINT
4070 NEXT I
4080 PRINT "END OF SCENARIO"
4090 PRINT
4100 PRINT "****************************************************************"
4110 PRINT
4120 REM ERASE ALL INSTRUCTIONS TO CONTROLLER & STOP T.I.C.
4130 WRITE (2,300)112;
4140 WRITE (2,300)216;
4150 DISP "E N D    0 F    S C E N A R I O"
4160 END
4170 REM **********************************************************************
```